Understanding the UBR Service Category for ATM Virtual Circuits

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Introduction

The unspecified bit rate (UBR) service category is one of five ATM service categories defined in the ATM Forum's Traffic Management Specification 4.0.

The five service classes are:

- Constant bit rate (CBR)
- Variable bit rate non-real-time (VBR-nrt)
- Variable bit rate real-time (VBR-rt)
- Available bit rate (ABR)
- Unspecified bit rate (UBR) and UBR+

UBR is intended for non-real-time applications that do not require any maximum bound on the transfer

delay or on the cell loss ratio.

The purpose of this document is to clarify the differences between a UBR permanent virtual circuit (PVC) and a variable bit rate, non-real time (VBR-nrt) PVC by illustrating that two such virtual circuits (VCs) with the same peak cell rate (PCR) experience very different bandwidth guarantees and scheduling priorities. These differences may affect the level of performance that users are provided on the connection.

Prerequisites

Requirements

There are no specific requirements for this document.

Components Used

This document is not restricted to specific software and hardware versions.

Conventions

For more information on document conventions, refer to the Cisco Technical Tips Conventions.

Advantages and Disadvantages of UBR

Following is a summary of the advantages and disadvantages of UBR VCs. This ATM service category has some important disadvantages related to bandwidth guarantees and scheduling priorities. These disadvantages are further illustrated in the next sections.

Advantages:

- Allows for a high degree of statistical multiplexing by not reserving any minimum bandwidth per VC. The VCs use the bandwidth up to the configured PCR when available.
- Models the best-effort service normally provided by the Internet. Suitable for applications tolerant to delay and not requiring real-time response. Examples include e-mail, fax transmission, file transfers, Telnet, LAN and remote office interconnections. Such applications are not sensitive to delay, but they are sensitive to cell loss. ATM switches, such as the Cisco Catalyst 8500 series, allocate larger maximum per-VC queue limits for UBR PVCs.

  Note: Queuing minimizes loss at the expense of greater delay.

  The following sample output from a Catalyst 8510 MSR with a feature card per-flow queueing (FC-PFQ) shows how an ATM switch allocates larger maximum queue limits by default for the non-real-time ATM service classes, including UBR.

```
Switch>show atm resource

   Resource configuration:
      Over-subscription-factor 8 Sustained-cell-rate-margin-factor 1%
```

```
Abr-mode: efci
   Service Category to Threshold Group mapping:
   cbr 1 vbr-rt 2 vbr-nrt 3 abr 4 ubr 5
   Threshold Groups:
   Group Max    Max Q  Min Q      Q thresholds Cell    Name
         cells  limit  limit      Mark Discard count
         instal instal instal
   ------------------------------------------------
   1     65535  63       63        25 % 87 %    0      cbr-default-tg
   2     65535  127      127       25 % 87 %    0      vbrrt-default-tg
   3     65535  511      31        25 % 87 %    0      vbrnrt-default-t
   4     65535  511      31        25 % 87 %    0      abr-default-tg
   5     65535  511      31        25 % 87 %    0      ubr-default-tg
   6     65535  1023     1023      25 % 87 %    0      well-known-vc-tg
```

Disadvantages:

- The only attributes specified as part of UBR are the PCR and the cell delay variation tolerance (CDVT). The PCR only provides an indication of a physical bandwidth limitation within a VC.

  Note: A relatively new variant of UBR, called UBR+, allows an ATM end-system to signal a minimum cell rate to an ATM switch in a connection request, and the ATM network attempts to maintain this minimum as an end-to-end guarantee. Refer to the document Understanding the UBR+ Service Category for ATM VCs.

- VCs of other ATM service categories have a higher priority as viewed by the ATM interface segmentation and reassembly (SAR) scheduler. When competition for a cell timeslot arises, the scheduler gives the timeslot to a VC of service classes with a higher priority.

- It does not place any bounds with respect to the cell loss ratio (CLR) or to the cell transfer delay (CTD). The end-system is expected to handle and adjust for any cell loss or delay.

- It does not guarantee cell delivery. Retransmission occurs at higher layers.

Despite these disadvantages, a well-designed ATM network implementing congestion control, traffic shaping at the end systems, and intelligent cell discard mechanisms such as early packet discard (EPD) or tail packet discard can provide reasonable support for UBR. In other words, any quality of service (QoS) provided to the UBR PVC results from the network design guidelines and the end system applications as opposed to anything operating within ATM.

Understanding Bandwidth Guarantees

This section illustrates how a router ensures that bandwidth guarantees are met by reserving or not reserving bandwidth for a particular VC depending on its ATM service class. In scheduling the next cell to be transmitted from a port, a process called the scheduler selects a cell from a PVC with guaranteed cell rates.

This table lists the cell rates that are guaranteed by the rate scheduler for each service category:

Service	Cell Rate Guaranteed

Category	
Constant bit rate (CBR)	PCR
VBR-rt	Sustained Cell Rate (SCR)
VBR-nrt	SCR
Available bit rate (ABR)	Non-zero Minimum Cell Rate (MCR) if specified
UBR+	Non-zero MCR if signaled by the router; applies to switched virtual circuit (SVCs) only on the PA-A3
UBR	None

Both ATM-attached routers and ATM switches take steps to meet bandwidth guarantees. The example below shows how a router accomplishes this.

In this example, PVCs are configured with service classes on a PA-A3 ATM port adapter.

1. Issue the **show atm interface atm** command. Note two key values: "`PLIM Type: SONET - 155000Kbps`" and "`Avail bw = 155000`". Since the interface does not yet support any PVCs, the available bandwidth equals the physical line rate.

```
Router#show atm interface atm 5/0
   Interface ATM5/0:
   AAL enabled: AAL5 , Maximum VCs: 4096, Current VCCs: 0

   Maximum Transmit Channels: 0
     Max. Datagram Size: 4528
     PLIM Type: SONET - 155000Kbps, TX clocking: LINE
     Cell-payload scrambling: ON
     sts-stream scrambling: ON
     0 input, 0 output, 0 IN fast, 0 OUT fast, 0 out drop
     Avail bw = 155000
     Config. is ACTIVE
```

2. Configure a PVC and assign it to the VBR-nrt ATM service class with an SCR of 50 MB.

```
Router(config)#interface atm 5/0
   Router(config-if)#pvc 1/200
   Router(config-if-atm-vc)#?
   ATM virtual circuit configuration commands:
    abr               Enter Available Bit Rate (pcr)(mcr)
    broadcast         Pseudo-broadcast
    class-vc          Configure default vc-class name
    default           Set a command to its defaults
    encapsulation     Select ATM Encapsulation    for VC
    exit-vc           Exit from ATM VC configuration mode
    ilmi              Configure ILMI management
    inarp             Change the inverse arp timer on the PVC
    no                Negate a command or set its defaults
    oam               Configure oam parameters
    oam-pvc           Send oam cells on this pvc
```

```
 protocol          Map an upper layer protocol to this connection.
 random-detect     Configure WRED
 service-policy    Attach a policy-map to a VC
 transmit-priority set the transmit priority for this VC
 tx-ring-limit     Configure PA level transmit    ring limit
 ubr               Configure Unspecified Bit Rate (UBR) for this interf
 vbr-nrt           Enter Variable Bit Rate (pcr)(scr)(bcs)

Router(config-if-atm-vc)#vbr-nrt 55000 50000 100
```

3. Issue the **show atm interface atm** command to see the new available bandwidth value. Note that the router subtracted bandwidth equal to the SCR of the VBR-nrt VC.

```
Router#show atm interface atm 5/0
   Interface ATM5/0:
   AAL enabled: AAL5 , Maximum VCs: 4096, Current VCCs: 0

   Maximum Transmit Channels: 0
     Max. Datagram Size: 4528
     PLIM Type: SONET - 155000Kbps, TX clocking: LINE
     Cell-payload scrambling: ON
     sts-stream scrambling: ON
     0 input, 0 output, 0 IN fast, 0 OUT fast, 0 out dropVBR-NRT : 50000
     Avail bw = 105000
     Config. is ACTIVE
```

4. Now create a UBR PVC with a PCR of 50 MB. The output of the **show atm interface atm** command confirms that the service class does not provide any minimum bandwidth guarantees, and the available bandwidth value remains the same as when the ATM interface simply supported the nrt-VBR PVC.

```
Router(config)#interface atm 5/0
   Router(config-if)#pvc 1/300
   Router(config-if-atm-vc)#ubr 50000

   Router#show atm interface atm 5/0
     Interface ATM5/0:
     AAL enabled: AAL5 , Maximum VCs: 4096, Current VCCs: 0

   Maximum Transmit Channels: 0
     Max. Datagram Size: 4528
     PLIM Type: SONET - 155000Kbps, TX clocking: LINE
     Cell-payload scrambling: ON
     sts-stream scrambling: ON
     0 input, 0 output, 0 IN fast, 0 OUT fast, 0 out dropVBR-NRT : 50000
     Avail bw = 105000
     Config. is ACTIVE
```

In other words, a router ATM interface allocates bandwidth first for the PCR of a CBR VC. Next, the VBR-rt and VBR-nrt classes are characterized by their PCRs and SCRs. Finally, you subtract the MCR of the ABR VCs. Any remaining bandwidth is available for the VCs of the other service classes like UBR. However, the amount of remaining bandwidth and when it appears is not guaranteed. Alternately, an advantage of UBR PVCs is that they allow for a high degree of statistical multiplexing by not reserving bandwidth per VC, even when a non-default PCR is configured.

Understanding Transmit Priority

In addition to setting any bandwidth guarantees, the ATM service category affects the priority assigned by the SAR chip on the ATM interface. As of Cisco IOS® Software Release 12.2(5), the SAR on the PA-A3 uses six internal transmit priority levels and assigns a default level to every VC. The transmit priority determines which queued cell is chosen to be transmitted out an interface during a cell time and ensures that ATM service classes which typically offer more robust QoS and traffic guarantees have a higher likelihood of access to the next cell timeslot.

The following table lists the ATM service classes and their default transmit priorities on the PA-A3.

Service Category	Transmit Priority
CBR, Operation, Administration, and Maintenance (OAM) cells and Signaling	0
ATM adaptation layer 5 (AAL5) or AAL2 Voice over ATM (VoATM) VC (any service category)	1
rt-VBR	2
nrt-VBR	3
ABR	4
UBR	5

Note: If you are using Cisco IOS Software Release 12.2(4) or earlier, only four SAR transmit priority levels are available. Configuring a VBR-nrt PVC with the PCR and SCR set to the same value provides equivalent real-time service class performance on the PA-A3 for CBR or VBR-rt for data.

On the PA-A3, issue the **transmit-priority** command in VC configuration mode to change the priority value. In the following sample, a custom prioritization scheme is configured by changing the transmit priority of a VC from four to two.

1. Create a UBR PVC and specify an optional PCR. By default, when you configure a PVC without specifying any shaping parameters, the router installs a UBR PVC with a PCR equal to the line rate of the physical ATM interface. In the following, a non-default PCR of 10 MB is configured.

```
Router(config)#interface atm 5/0
   Router(config-if)#pvc 1/100
   Router(config-if-atm-vc)#ubr ?
    <1-155000> Output Peak Cell Rate (PCR) in Kbps

   Router(config-if-atm-vc)#ubr 10000
```

2. Issue the **show atm vc [*vcd#*]** command to view the characteristics of your PVC. Note how the router assigns a default transmit priority value of four to the UBR PVC.

```
Router#show atm vc 2
   VC 2 doesn't exist on interface ATM2/0
```

```
ATM5/0: VCD: 2, VPI: 1, VCI: 100
UBR, PeakRate: 10000
AAL5-LLC/SNAP, etype:0x0, Flags: 0x20, VCmode: 0x0
OAM frequency: 0 second(s)
PA TxRingLimit: 0 particles
PA Rx Limit: 0 particles
InARP frequency: 15 minutes(s)
Transmit priority 4
InPkts: 0, OutPkts: 0, InBytes: 0, OutBytes: 0
InPRoc: 0, OutPRoc: 0, Broadcasts: 0
InFast: 0, OutFast: 0, InAS: 0, OutAS: 0
InPktDrops: 0, OutPktDrops: 0
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0
OAM cells received: 0
OAM cells sent: 0
Status: ACTIVE
```

3. Enter VC configuration mode and configure a non-default transmit priority value. Take care to avoid using a transmit priority of one, which should be reserved for control traffic like OAM and signaling.

```
Router(config)#interface atm 5/0
   Router(config-if)#pvc 1/100
   Router(config-if-atm-vc)#?
   ATM virtual circuit configuration commands:
    abr                 Enter Available Bit Rate (pcr)(mcr)
    broadcast           Pseudo-broadcast
    class-vc            Configure default vc-class name
    default             Set a command to its defaults
    encapsulation       Select ATM Encapsulation for VC
    exit-vc             Exit from ATM VC configuration mode
    ilmi                Configure ILMI management
    inarp               Change the inverse arp timer on the PVC
    no                  Negate a command or set its defaults
    oam                 Configure oam parameters
    oam-pvc             Send oam cells on this pvc
    protocol            Map an upper layer protocol to this connection.
    random-detect       Configure WRED
    service-policy      Attach a policy-map to a VC
    transmit-priority   set the transmit priority for this VC
    tx-ring-limit       Configure PA level transmit    ring limit
    ubr                 Configure Unspecified Bit Rate (UBR) for this inte
    vbr-nrt             Enter Variable Bit Rate (pcr)(scr)(bcs)

    Router(config-if-atm-vc)#transmit-priority ?
      <1-4> priority level

    Router(config-if-atm-vc)#transmit-priority 2
```

4. Issue the **show atm vc [*vcd#*]** command again to confirm your settings. Note how the router indeed changed the transmit priority to two.

```
Router#show atm vc 2
   VC 2 doesn't exist on interface ATM2/0
   ATM5/0: VCD: 2, VPI: 1, VCI: 100
   UBR, PeakRate: 10000
   AAL5-LLC/SNAP, etype:0x0, Flags: 0x20, VCmode: 0x0
   OAM frequency: 0 second(s)
```

```
PA TxRingLimit: 0 particles
PA Rx Limit: 0 particles
InARP frequency: 15 minutes(s)
Transmit priority 2
InPkts: 0, OutPkts: 0, InBytes: 0, OutBytes: 0
InPRoc: 0, OutPRoc: 0, Broadcasts: 0
InFast: 0, OutFast: 0, InAS: 0, OutAS: 0
InPktDrops: 0, OutPktDrops: 0
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0
OAM cells received: 0
OAM cells sent: 0
Status: ACTIVE
```

It is important to note that the transmit priority changes only the likelihood that the VC will be given priority access to a particular cell timeslot. Transmit priority does not change the behavior of the SAR scheduler and does not implement a minimum bandwidth guarantee. All UBR PVCs continue to provide best-effort delivery.

Comparing PCR with VBR-nrt and UBR PVCs

When provisioning ATM PVCs with a public carrier, it is important to understand the differences in how VBR-nrt and UBR are handled by both the ATM end-systems like a Cisco router and by the ATM switches. It is important to understand that the ATM service class defines more than the traffic rates, such as peak cell rate. The ATM service class defines how the ATM network devices and the router treat the cells of VC with respect to bandwidth guarantees, delay and cell loss.

Note: The two ends of an ATM physical link can be configured with different service classes. The service class type is not carried anywhere in the cell header. However, if you choose to do so, keep in mind the above differences in how the VC traffic is handled.

Network Design Considerations

When provisioning ATM PVCs and selecting an ATM service class for these VCs, consider these questions:

- Do you need to provide bandwidth guarantees for your users?
- Do you need to provide bounds on delay and cell loss?

Related Information

- **Understanding the CBR Service Category for ATM VCs**
- **Understanding the VBR-nrt Service Category and Traffic Shaping for ATM VCs**
- **Understanding the Variable Bit Rate Real Time (VBR-rt) Service Category for ATM VCs**
- **Understanding the Available Bit Rate (ABR) Service Category for ATM VCs**
- **Understanding the UBR+ Service Category for ATM VCs**
- **Understanding Router Support for ATM Real-Time Service Categories**
- **More ATM Information**
- **Technical Support - Cisco Systems**

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