DOCSIS™ TOOLS FOR TIERED DATA SERVICES

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Abstract

Given that tiered data service is a good economic idea (and a growing volume of data support this), how does the operator implement a solution? This paper discusses the technical tools available in DOCSIS for implementing both "Speed" and "Included Bytes" tiers.

INTRODUCTION

Business Case

Cable data system usage has been studied for several years now and a growing body of work is available that indicates tiering curbs extreme consumption behavior. On an untiered network, 80% of the total available bandwidth is consumed by only 12% of the subscribers. On a tiered network, 80% of the bandwidth is consumed by 25% of the subscribers, showing a more even distribution of consumption. Given that the majority (>70%) of High Speed Data (HSD) subscribers consume less than 2 GB (GigaBytes, where 1 GB = 1,000 MegaBytes) of data a month (combined upstream and downstream), curbing the extreme consumption of a few users will free up bandwidth for more "average" usage subscribers and the revenue they bring in.

That's about it for business motivation, the data are in and tiering makes economic sense. The remainder of this paper discusses technical methods to implement tiering on a DOCSIS network.

Types of Tiers

There are two types of tiers:

- Speed: Usually an instantaneous number measured in kilobits or megabits per second. This is how "fast" the CM is allowed to operate on the network. There can be separate speeds for the forward and return paths.

- Included Bytes: Usually measured over a period of time such as a month, this is the total amount of traffic through a CM. It is usually measured as an aggregate of both forward and return traffic, though separate tiers are possible for each direction.

DOCSIS provides a set of tools to implement both speed and Included Bytes tiers; however, the methods can differ between DOCSIS 1.0 and DOCSIS 1.1. Specifically the operator has more choice and arguably better options available to them with DOCSIS 1.1. But there are ways to get it done regardless of the version of DOCSIS deployed.

Overall System View

This paper discusses how tiers can be implemented on a cable data system. Collecting DOCSIS usage data is one part of the overall solution needed to implement tiers. A representation of the overall system is shown in Figure 1.

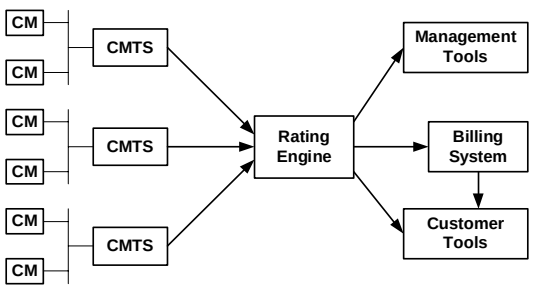

Figure 1

The items in Figure 1 to the right of the CMTS are not discussed in detail in this paper although they are important considerations for the back-office.

Usage data can be collected in either the CM or CMTS through methods described in this paper. A Rating Engine processes the data where business decisions are made to turn the raw usage information into a line item for the billing system. There are also tools to both allow the operator to manage the system and to allow customers to track their usage before the bill shows up at their door.

Collecting the usage data, while there are several methods available, is probably the most straightforward step of the entire process. Processing that data into billing information will be unique for each operator.

SPEED TIERS

Description

This type of tier defines the maximum speeds that a user will have over the DOCSIS connection. It is possible to define maximum speeds on both the upstream and downstream connection.

Example speed tiers are a user having speeds of 128 kbps on the return path and 1.5 Mbps on the forward path. The cable operator sets these numbers and it is possible to assign different speed tiers to different groups of subscribers.

The speeds are assigned to the Cable Modem (CM) through the CM configuration file, which is a list of instructions created by the cable operator and provided to the CM every time it boots. There are many parameters in the CM configuration file that the operator uses to define the data "service" provided to the user, but only a couple of the parameters are needed to create the speed tier.

Choosing a speed tier begins with the operators service activation system. When a subscriber requests HSD service, the operator generally offers a choice of several speed tiers to choose from. The service activation system communicates the speed tier information to the provisioning system where the corresponding configuration file is created and assigned to that subscribers' CM. When the CM boots, it is provided that configuration file with the appropriate speed tier information as illustrated in Figure 2.

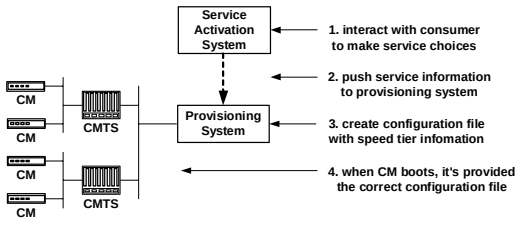

Figure 2

Speed Tiers: DOCSIS 1.0

In DOCSIS 1.0, the maximum speeds are not guarantees, rather the system will provide up to that speed if there is capacity available on the system. There are several reasons why the full speed may not be available, and primary among these is having too many users attempting to access the system at the same time. All networks are shared at some point and engineering enough bandwidth for peak usage can solve congestion.

In the DOCSIS 1.0 configuration file, the following two parameters are used to create speed tiers for the downstream and upstream paths:

- Maximum Downstream Rate Configuration Setting
- Maximum Upstream Rate Configuration Setting

These parameters are simply set to the desired speeds and the system enforces them to ensure the CM does not transmit at speeds higher than allowed by their tier.

Speed Tiers: DOCSIS 1.1

DOCSIS 1.1 supports many Quality of Service (QoS) parameters, the vast majority of which are not needed to implement speed tiers. While DOCSIS 1.1 QoS is complex, it is as simple as DOCSIS 1.0 to implement speed tiers.

In the DOCSIS 1.1 configuration file, the following two parameters are used to create speed tiers for the downstream and upstream paths:

- Downstream Maximum Sustained Traffic Rate
- Upstream Maximum Sustained Traffic Rate

The names of the parameters have changed to reflect that DOCSIS 1.1 offers a complete Quality of Service (QoS) package. These two parameters are part of that larger QoS package, however, they function exactly the same and cause the same effect as the DOCSIS 1.0 parameters.

INCLUDED BYTES TIERS

Description

Included Bytes tiers are sometimes referred to as consumption tiers. This type of tier counts how many Bytes of data are used by the CM over a period of time. An analogy is to the mobile phone industry that for example offers several "Included Minutes" tiers that include an allowed number of minute's usage over one month. Similarly a fairly standard entry-level tier for HSD is including 2 GigaBytes (GB) of usage over one month. Data shows that the majority of HSD users consume less than 2 GB per month. For usage beyond the tier amount, the operator business policy implemented in the Rating Engine would determine the appropriate billing treatment for that subscriber.

The Included Bytes tier is generally a combination of both the upstream and the downstream usage as shown in Figure 3 below. An operator could choose to offer separate tiers for upstream and downstream usage.

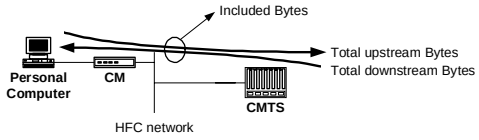

Figure 3

The amount of Bytes included in these tiers should come from the operators own investigation and business plan. Two GigaBytes is equal to 2,000 MegaBytes and is a reasonable amount of data for a subscriber just doing email and web surfing. Users that are heavy into peer-to-peer applications or that include large attachments with email or do a lot of file transfer may consume more that this.

Unlike Speed Tiers that are implemented using the CM configuration file through an interaction with the provisioning system, Included Bytes tiers are implemented by counting the number of Bytes of data that are sent and received through a particular CM.

Different methods are available for aggregating the Bytes of data through a CM depending if the system is DOCSIS 1.0 or DOCSIS 1.1. These methods are described in the following sections.

CM Byte Counters

While this method works with all DOCSIS versions, it is the only DOCSIS-defined method of gathering consumption information for DOCSIS 1.0 systems. A subsequent section describes enhancements available when using a DOCSIS 1.1 CMTS.

All DOCSIS CMs are required to implement Management Information Base

(MIB) objects that can be polled using the Simple Network Management Protocol (SNMP). Several of the required MIB objects include counters that track the number of upstream and downstream Bytes through that CM.

The operator can use an SNMP workstation, also known as a Network Management Station (NMS), to periodically poll each cable modem to collect downstream and upstream usage information as shown in Figure 4. Once polled for, the usage data is passed to the Rating Engine for analysis per operator business rules.

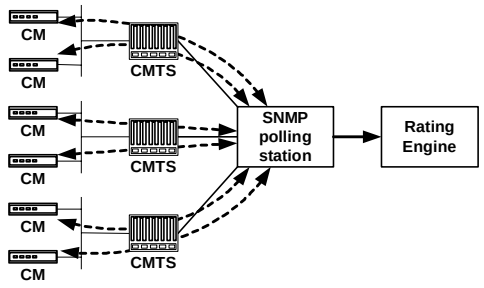

Figure 4 – Using SNMP to Poll CM counters

The time interval the NMS uses to poll all the CMs on the network is an issue to be considered for several reasons. As subscribers can power off their CMs, usage information may be lost from time to time. When the CMs are powered on, the MIB counters are not required to reset to zero (an implementation detail with MIBs, its just how they work). The NMS has to poll once just to get a baseline number from which to calculate further Byte usage.

In order to detect when a CM has been rebooted, there is a MIB object that contains the date/time of when the CM last rebooted. The operator can use this information to learn if the baseline number for this particular CM has changed.

While polling CM Byte counters is a simple and easy method supported by DOCSIS 1.0 to implement Included Bytes tiers, using CM counters may not be a highly reliable method due to the unpredictability of CMs being power cycled in the home. It will be hard to guarantee accurate counts, in fact, the operator can expect to undercount usage due to the issues listed above.

Another reason to carefully adjust the polling interval is the amount of traffic the SNMP polling of CMs places on the DOCSIS network. There can be thousands of CMs attached to a CMTS and polling too often can add appreciable traffic to the cable data network. Depending on the number of CMs on the network and the polling interval, the SNMP polling traffic can comprise up to 5% of the bandwidth of the cable data system. This is not a trivial number as this is bandwidth that could otherwise be charged for.

CMTS Byte Counters

DOCSIS 1.1 requires the CMTS to implement MIBs that count upstream and downstream Bytes on a per CM basis. Instead of polling all the CMs, the operator can now poll just the CMTS as shown in Figure 5. Note a DOCSIS 2.0 CMTS is required to have these same counters and this method is equally viable there.

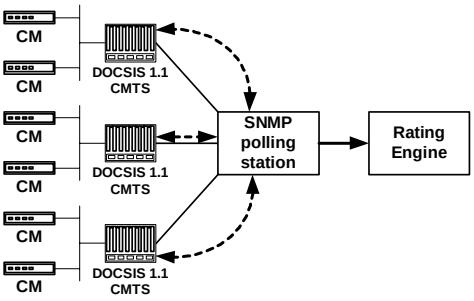

Figure 5 – Using SNMP to poll CMTS counters

This method still uses SNMP to poll the MIB counters at the CMTS, but since a CMTS is not supposed to be power cycled that often, the polling frequency can be greatly reduced to minimize the amount of SNMP traffic needed to collect the data. In fact the Byte counters required in the CMTS were designed to count very high specifically to allow the operator to poll the CMTS only once a month. As long as the CMTS is not power cycled, the counters will accurately count trillions of GigaBytes and it is highly unlikely a subscriber could consume that amount of data over a month. Using CMTS polling, subscribers can power cycle their CMs as often as they want and the CMTS will still keep accurate counts of their bandwidth consumption.

A complete rollout of DOCSIS 1.1 is not needed to take advantage of this easier , more reliable, and more accurate method to aggregate Byte count information. By only implementing a DOCSIS 1.1 CMTS and leaving the CMs at DOCSIS 1.0, the rest of the network, e.g., the back-office, does not need to be modified to support DOCSIS 1.1. Said another way, if only the CMTS is upgraded to DOCSIS 1.1 (all the CMs are 1.0), no changes are needed to the DOCSIS backoffice for provisioning DOCSIS 1.1 CMs. The already deployed DOCSIS 1.0 CMs will operate on the DOCSIS 1.1 CMTS with all the expected features available with DOCSIS 1.0.

3rd Party Counting System

Another option for measuring cable modem bandwidth consumption is to place a traffic counting device between the CMTS and the Metro IP aggregation network. This device is capable of counting the traffic into and out of an operator's DOCSIS network as shown in Figure 6.

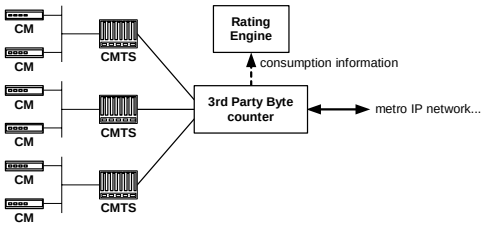

Figure 6 – 3rd Party Byte Counter

This solution does not depend on the version of DOCSIS deployed. In fact, this solution works with non-DOCSIS cable data systems too and so may be a consideration for operators that have both DOCSIS and proprietary data systems in the same metro area.

The 3rd party counting system can be approached in several ways. Some Ethernet switch equipment can aggregate traffic from several CMTSes into a single data stream as shown in Figure 7. This aggregation switch also takes on the additional processing task of Byte counting. On a periodic basis, consumption information is transferred from the switch to the rating engine.

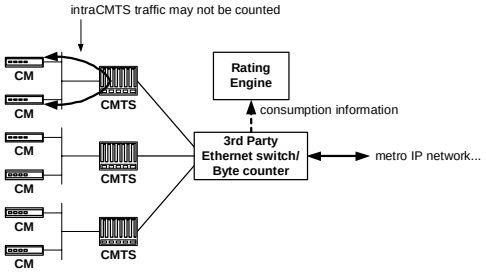

Figure 7

The configuration shown in Figure 7 is not capable of counting traffic that "stays at home" on a particular CMTS. That is, intraCMTS traffic from CM to CM on a single CMTS will not pass through the Byte counter as shown in Figure 7.

Another approach entails placing a traffic monitoring/traffic shaping device in a data

path of already aggregated CMTS traffic as shown in Figure 8.

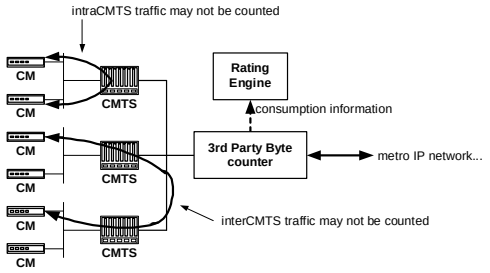

Figure 8

As shown in Figure 8, both intraCMTS data traffic and traffic between CMTSes may not be counted with this configuration.

Finally, using a 3rd Party counting system, in either configuration, has the potential to introduce a single-point of failure in the data network that could affect more than one CMTS worth of traffic. A system used for measurement purposes only, however, may not have this characteristic. It depends on the product.

SUMMARY

There are two types of data tiers, Speed and Included Bytes. Speed tiers are implemented through the CM configuration file. Included Bytes tiers are implemented by monitoring usage data from any of several sources, though some sources are more reliable than others. Tools exist in DOCSIS to implement both types of tiers.

DOCSIS 1.0 and DOCSIS 1.1 support very similar methods to implement speed tiers. However, DOCSIS 1.0 and DOCSIS 1.1 systems provide different methods to implement Included Bytes tiers. The DOCSIS community was more aware of the need for implementing data tiers in DOCSIS 1,1, therefore, that system has a more simple method to collect consumption data from the CMTS, whereas in DOCSIS 1.0 this information has to be collected from the CMs.

A key piece of equipment needed for the overall tiering system is the Rating Engine. DOCSIS only provides a technical means to implement tiers, whereas the Rating Engine is need to turn the raw data into billing information. The Rating Engine is not standardized in DOCSIS, rather, this functionality will be specific to each operator.

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