Cambium Networks™

PMP 450 MaxBurst MIR

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CARRIER CLASS ETHERNET CONTROL

Establishing appropriate **Service Level Offerings** for your customer base creates a framework for satisfaction and upselling – key drivers for success. **Cambium Networks has developed unique control mechanisms that enable service providers to manage and control wireless networks at a higher degree of sophistication to meet the needs of customers.**

The world of fixed wired Ethernet services has developed traffic shaping, metering, and policing techniques that provide broad flexibility for establishing tiered service offerings. Service providers need solutions that provide a high degree of flexibility and control, while also ensuring overall network bandwidth consumption integrity and control. They need tools to generate a quick ROI from various tiers of service offerings, while constantly being sensitive to providing a fair and valued user experience to your customers to maximize satisfaction and reduce churn.

CAPPING BANDWIDTH

In contention based broadband systems, bandwidth is allocated on a first come, first served basis across all users. For very small networks, this typically does not pose a problem. However, as the number of users increases, and the number of users streaming large files such as video increases, one user can effectively monopolize the data frame and delay other users from being scheduled until the next frame. Although this may satisfy the one user, other users are forced to wait for bandwidth to be available. This will affect customer satisfaction as it can slow down or create inconsistent speeds, and may increase latency.

One way to throttle high-bandwidth users is by simply capping their bandwidth. This effectively sets the maximum download and/or upload speed for a user by setting a threshold in the system to conform to a maximum data rate. For example, a cap can be set to 10 Mbps, meaning that the user cannot ever download at speeds faster than 10 Mbps under any circumstances. Many service providers use bandwidth caps as the fundamental control to throttle throughput.

However, capping bandwidth has performance limitations. This basic level of control provides some help but constrains throughput even in times when additional network capacity is available. Furthermore, a transaction can typically consist of downloading a large amount of data and then remaining idle while the end user reads or consumes the information. For example, downloading a high-resolution image will consume a large amount of bandwidth for a short time, and then the user may not need bandwidth while he files the image into a local folder.

Simple bandwidth caps fall short of the goal of meeting the needs of service providers and end users. Maximizing the efficiency of network usage — getting users on and off the network quickly — will in totality free the network for other users. The longer that a user is accessing the bandwidth resource, the more likely that network congestion may affect the experience of other users. Tailoring the link to perform the way that end users consume data improves data flow and customer satisfaction.

MIR AND BURST DATA RATE

To help manage this type of network traffic usage patterns, Cambium Networks implemented a more sophisticated method to control bandwidth by allowing the setting of a sustained data rate referred to as Maximum Information Rate (MIR). To account for the "bursty" nature of bandwidth demand, Cambium Networks complemented MIR by developing the Burst Bucket.

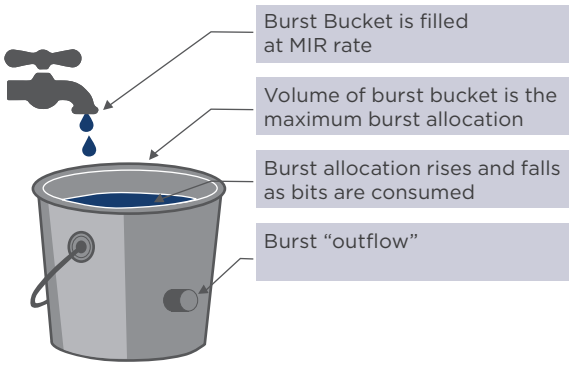
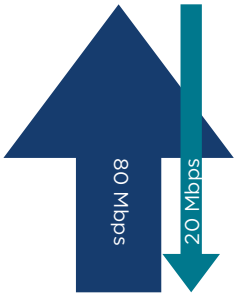


Figure 1: Burst Bucket Theory

The allocation Burst Bucket, sometimes referred to as a token bucket, is a virtual "container" of bits. These bits are stored up during idle periods and can be used by a Subscriber Module (SM) to consume a limited amount of bandwidth at a rate greater than the link's MIR. This enables a user's data rate to be temporarily higher for a short duration to support periodically downloading large files. As a result, emails, web pages, movies, images, or other files are quickly transferred so that the network can be idle and available for other users while the downloaded data is consumed.

As an example that we will use throughout this paper, consider that the total aggregate data rate of the link is 100 Mbps, with a downlink ratio of 80/20 — meaning 80 Mbps in the downlink and 20 Mbps in the uplink. Assume that the MIR of this link is set to 10 Mbps and that the burst bucket size is 400 Mb.

Figure 2: 100 Mbps Total Throughput in 80/20 Ratio



When network operators plan their network architecture around usage and oversubscription rates, consideration must be given to reducing delays caused by contention. Resolving potential contention issues enables the end user to enjoy a faster connection for bursting-type activity while enabling the service provider to throttle back more sustained large-download and constant-streaming activity.

IMPLEMENTING THE BURST BUCKET IN MULTIPOINT ACCESS NETWORKS

The Canopy system has been using MIR and Burst Bucket technology for more than a decade. These tools truly enable network operators to offer tiered services and provide consistently reliable connectivity for end users. The following provides a detailed description of MIR functionality.

In general, the performance of the Burst Bucket can be calculated as follows:

Achieved download rate – MIR rate = Burst Bucket Consumption Rate

Referring to the example outlined above, a network has a maximum download rate of 80 Mbps, a MIR of 10 Mbps and a bit bucket allocation of 400 Mb to use to meet burst demands. In this example, if the MIR is configured to 10 Mbps, and the "achieved burst rate" is 50 Mbps, then the Burst Bucket would be consumed at 40 Mbps.

50 Mbps – 10 Mbps = 40 Mbps

When the achieved rate is less than MIR, the Burst Bucket is "refilled" at the difference between the achieved rate and the 10 Mbps MIR. In this case, if the link is completely idle, the Burst Bucket would be "refilling" at 10 Mbps — enough to fill a 400 Mb bucket in 40 seconds.

Time to Refill Burst Allocation Bucket

400 Mbps/10 Mbps = 40 seconds

Figure 3: User Throughput Experience when Demand is Above MIR / Emptying the Burst Bucket

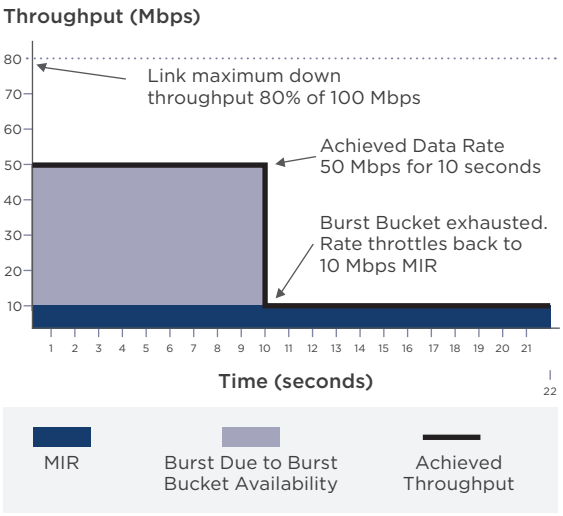
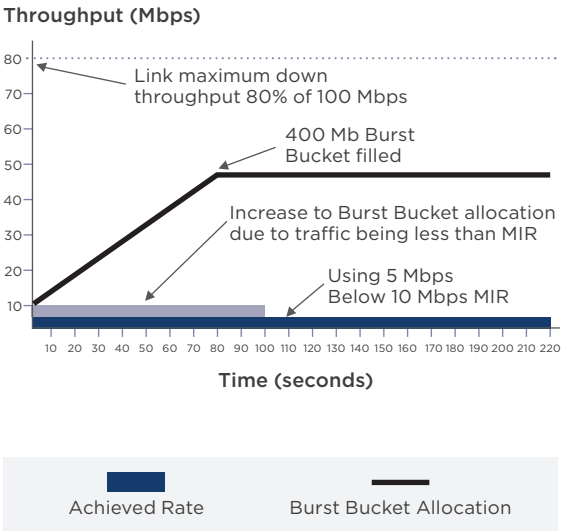


Figure 4: User Throughput Experience when Demand is Below MIR / Refilling the Burst Bucket



The bucket bits are consumed at the delta rate between the MIR and the active data rate — the "achieved burst rate."

As the link is rarely completely idle, as long as the usage rate is lower than the configured MIR, the bucket will be continuously "refilled" at the delta rate. In a case where the active rate is 5 Mbps and the MIR is 10 Mbps, the delta rate is 5 Mbps — enough to fill a 400 Mb bucket in 80 seconds.

400 Mb/5 Mbps = 80 seconds

In this case, the SM bursting would take as much throughput per frame as it was allowed by the AP. Cambium Networks offers a portfolio of solutions, each with different throughputs, so that network operators can tailor performance to meet their needs.

PMP 450: HIGHER THROUGHPUT AND MAXBURST DATA RATE

The PMP 450 Burst Bucket is increased to 2.5 Gb to give service providers more flexibility to allow users to burst for significantly larger data amounts. The 2.5 Gb Burst Bucket, coupled with the high throughput per AP, is specifically designed to allow the burst of a full length movie, thereby enabling customer satisfaction when downloading such content over a PMP 450 wireless network.

Module	Max Throughput	Burst Bucket Maximum
PMP 100 Series	14 Mbps	500 Mb
PMP 430 Series	45 Mbps	500 Mb
PMP 450	125 Mbps	2.5 Gb

Allowing bursts up to the allowed data rate would potentially not incentivize end users to buy higher tiers of service, since with such a high burst rate capability they could always be getting much faster service. Also, for service providers, not being able to fully control the burst rate could mean that the capacity in their links would be very quickly saturated by bursting traffic with no means to limit the activity beyond the controls of MIR and bucket size. With only these two controls, the network operator could be forced to constrain MIR and the Burst Bucket to levels that would severely throttle activity and yield a poor user experience to end customers.

To alleviate this constraint, Cambium Networks developed the concept of MaxBurst data rate. This second level of throttling control enables the service provider ***to cap the burst rate*** while still allowing bursting to occur. With MaxBurst data rate, providers can not only tier their levels of service using traditional MIR controls, they can further refine those tiers with burst profiles with a combination of Burst Bucket size and a maximum burst rate.

The MaxBurst data rate capability is in effect a second "faucet" to the burst bucket on all Cambium PMP solutions that enables service providers to effectively control speed and bandwidth allocation in an environment where multiple users are streaming video content.

Figure 5: MaxBurst Sustained Data Rate

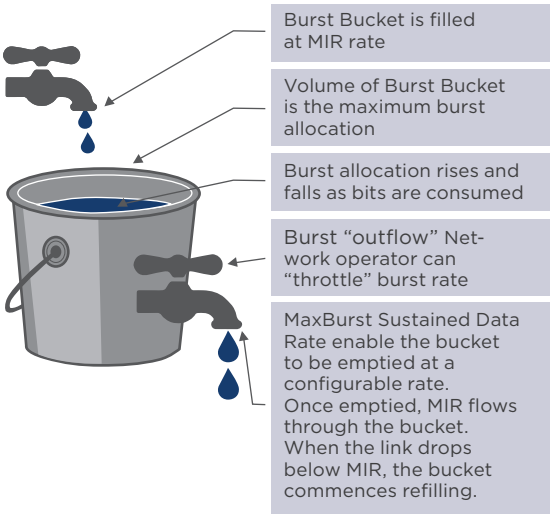
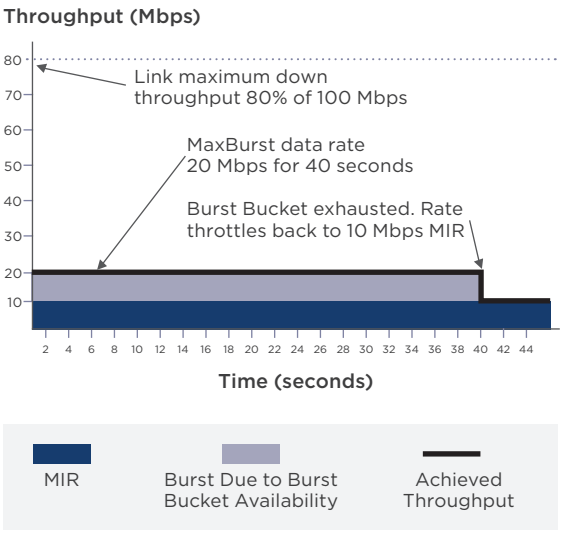


Figure 6: User Throughput Experience when Demand is Above MIR / And Capped by MaxBurst



Using the scenario described above, if a MaxBurst data rate is configured to 20 Mbps with a Burst Bucket size of 400 Mb, then the end user (having purchased a 10 Mbps MIR data package) would be able to realize a 20 Mbps data rate for 40 seconds.

High Speed MaxBurst Data

400 Mb/(20 Mbps-10 Mbps MIR) = 40 seconds

After 40 seconds is up, the link is throttled back to the 10 Mbps MIR. This mechanism enables service providers to tier service offerings effectively and not allow a runaway link.

CONTROLS FOR FLEXIBILITY AND CUSTOMER SATISFACTION

Service providers and private network operators need solutions that offer high capacity throughput — and controls to manage service delivery effectively. MIR, the Burst Bucket, and MaxBurst data rate enable flexibility to allow a wide range of options. As video continues to be consumed over IP networks, these capabilities enable service providers to offer tiered services effectively and deliver against customer satisfaction expectations.

Cambium Networks has years of experience innovating technology solutions that increase the scalability and resilience of broadband wireless access networks. These technologies make networks able to continue to provide end user satisfaction under demanding conditions.

TERMS

AP	Access Point
Burst Allocation	Configuration parameter specifying the size of the Burst Bucket
Burst Bucket	Theoretical container of bits allowing an SM to consume bandwidth at a higher rate than MIR
MaxBurst	Configuration parameter capping the rate that the Burst Bucket can be consumed
MIR	Maximum Information Rate. A configuration parameter specifying how fast the Burst Bucket is filled. When the Burst Bucket is empty, the SM is capped to this level of throughput.
SM	Subscriber Module

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