Improving CDN Capacity Utilization with Peak-Load Pricing
Whether it’s world cup soccer, a royal wedding or a presidential inauguration, a similar scenario unfolds online when millions of fans log on to their broadband service to view the action. They experience bandwidth bottlenecks brought about by peak demands on the network.

Content Delivery Networks (CDNs) will need to provision the capacity to accommodate this extraordinary demand or risk provoking the ire of their content provider customers. The problem with provisioning to peak usage, however, is that it leads to weak capacity utilization at off-peak times.

Increasingly, industries facing wild fluctuations in capacity utilization are turning to “peak load pricing.”

• Many public transit systems charge higher fares during rush hour, since it is this peak usage that drives the demand for vehicles and infrastructure.
• Electric utilities often offer price incentives to large corporations that shift energy consumption to hours of lesser demand. This can allow a utility to defer construction of costly new power plants, which must accommodate peak demand.
• CDNs will surely begin to experiment with peak load pricing too as a way to more efficiently utilize existing bandwidth and defer the costs of provisioning additional network capacity. This is particularly important to telco operator CDNs, who are building and managing their own Content Delivery Networks largely to forestall costly capital expenditures for network expansion.

CDNs currently factor peak usage into their pricing via “95th percentile billing” — also known as 95/5 or “burstable billing” — where they charge content providers based on an approximation of their peak bandwidth utilization. But this method is fundamentally flawed because, unlike true peak load pricing, it does not motivate a CDN’s customers to shift usage to the network’s off-peak times.

With this white paper we will demonstrate how Content Delivery Networks (especially operator CDNs) can transcend the limitations of 95th percentile billing to establish pricing policies that more closely parallel true peak-load pricing and, in turn, maximize revenue and control costs.
The Problem

The general philosophy behind peak-load pricing holds that:

- Users at peak times must contribute to the capital costs of additional capacity while off-peak users only need to cover the operating costs incurred in their servicing.
- Price incentives should be used to motivate customers to shift their usage from peak days and times to off-peak hours.

With the burstable billing that CDNs and other telco services often employ, customers pay based on the 95th percentile point of bandwidth usage, measured at five-minute increments over the course of a month. This pricing method makes perfect sense when all customers have similar consumption patterns and when 95th-percentile usage is always close to average usage. However, in CDN operations, these assumptions often do not hold. As such, this billing method has serious drawbacks and may even lead to unnecessary capital expenditures for additional network capacity.

Inherently, 95th percentile billing assumes that the top 5% of usage represents “noise” and that the remainder represents “typical” usage. Unfortunately, the choice of 5% as a cutoff percentile may be no better than arbitrary. For illustration, consider three different CDN customers.

With 95th percentile billing, all three of the following customers will be charged on the basis of 1000 Mbps, despite their widely varying usage patterns.
It certainly seems fair that this first customer — who consistently consumes 1000 Mbps of bandwidth — gets charged on that basis.

It may also seem relatively fair that the second customer gets charged on that basis, as it usually consumes 1000 Mbps and its usage above that level might constitute “noise.” But what if its 4% highest-use time periods come at peak times for the CDN as a whole? If so, this customer may be driving significant additional peak capacity demands on the CDN without bearing any of the costs involved.
The third customer may have a legitimate grievance, however. Its base usage sits an order of magnitude below the level for which it is charged and its total usage of the CDN’s resources falls far below that of other customers that pay the same amount. And, this customer’s peak usage might not even be driving additional capacity requirements if its peak times do not coincide with network peak loads.

These examples expose the greatest flaw in 95/5 pricing, a “one size fits all” approach.

**Why the Problem Exists**

- **95/5 Billing is Based on Per-Customer Peak Usage, Not System Peak Usage**

If a CDN’s customers all had the same time-of-day and day-of-week demand profiles, then each customer’s peak usage would perfectly coincide with the system’s peak usage. But that’s not the case.

A customer that streams entertainment videos will typically require the most bandwidth during hours that viewers are not at work, whereas a customer supplying business-related content may experience its greatest usage during work hours.

Suppose then that an operator CDN consistently encounters peak usage on Saturday afternoons; the goal of peak load pricing would be to charge customers a premium for bandwidth consumed on Saturday afternoon to incentivize them to shift demand away from that day and time. This shouldn’t affect the business-related content owner because its traffic occurs primarily during regular work days, right?
Unfortunately, here’s where the wheels begin to fall off of 95th percentile billing.

With burstable billing, the business content customer would be charged on the basis of its own peak usage rather than on the system’s peak usage. This pricing strategy does nothing to incentivize the customer to shape bandwidth demand. In fact, it actually encourages the customer to shift more demand to its off-peak times — which, in this case, might actually compound Saturday afternoon network congestion and force the CDN into additional capacity investments.

• Determining Peak Load Periods Is Not Straightforward

Suppose that an operator CDN agrees that pricing should be based according to peak aggregate demand, rather than peaks in individual customer demand. It would next need to determine when aggregate peak load times occur.

That’s easier said than done, however.

Neither CDN capacity planning nor capacity utilization are carried out at the network level, so identifying this kind of peak load information cannot be accomplished at that level. Instead, edge servers and other infrastructure are provisioned separately at each edge location or point of presence (PoP), based on geographical variations in bandwidth demand.

For any CDN with a large geographical footprint, different PoPs will experience peak loads at different times. Even if viewers within the coverage area consume online content at similar times of their days, they will do so in different time zones. This points to the need to determine peak load times separately for each node in the network.
A CDN whose traffic and infrastructure are located primarily in Europe will witness peak load times that coincide with the hours of greatest European usage. It would be counterproductive, however, for this CDN to penalize a customer that distributes lots of data through Latin America nodes during these same hours. In fact, it should reward this customer for utilizing surplus capacity during times of slack demand in Latin America.

Differences in bandwidth demand may not be as pronounced when end users extend over just a few time zones, but it can still be significant. Even within the same time zone, cultural factors may create significant variations in time-of-day patterns. For example, within the principal European time zones, some countries follow a “siesta” tradition of a long mid-day break and a later end to the work days while other countries do not. This underscores how much peak-time patterns can vary.

**The Solution**

To rectify the inequities with current billing practices then, operator CDNs must adopt an improved pricing approach that addresses the following issues:

- 95th percentile billing does not adequately represent the differences in demand patterns among various customers.
- A rationalized pricing system must reflect peak load demands against infrastructure, not just peak usage by individual customers.
- Peak load infrastructure demands must be identified on the same basis as capacity is provisioned locally, not on a network-wide level.

**Citrix® Enables Rationalized CDN Pricing**

Historically, CDNs have not been able to track and bill customer usage — and system demands — in a way that can address all of the above issues. While 95th percentile billing may have been adequate in early, localized networks with homogeneous customer bases, it has not evolved to accommodate the complexities of today’s CDNs and their customers.

CDNs have been reluctant to update their pricing methods because of the data management difficulties involved; just providing accurate burstable billing has been challenging enough. Fortunately, the powerful analytics and reporting tools of Citrix Content Delivery Analytics™ can empower network providers to create and execute fully rationalized pricing approaches.

**Identify Peak Load Usage Patterns for Individual Network Components**

Citrix’s advanced multidimensional data capture and analysis capabilities enable operator CDNs to precisely identify times and days of peak bandwidth usage down to the individual PoP.

Citrix captures all the data from CDN log files and analyzes it continuously as it loads, providing an up-to-date view of edge location usage. You can identify the 95th (or other) percentile for usage of each network node. You can even identify which time periods experience usage at or above a designated percentage of the peak level and use it to create differentiated rates by PoP and time-of-day/day-of-week that reflect true usage patterns.
For example, an operator CDN could establish an off-peak rate per megabyte (MB) transferred and a separate peak-time rate per MB for each continent, each time zone, or even each individual PoP. However you choose to tailor such a rate structure, Citrix Content Delivery Analytics can provide the detailed analytic support necessary to create and manage it. This will ensure that the end result treats each of your customers fairly while reflecting your true cost structure.

**Track and Bill Network Usage by Customer and Edge Location**

Even after a CDN deploys a truly rationalized rate structure, it must still properly assess bandwidth consumption by each customer and correlate it to the differentiated price factors. Fortunately, Citrix can also help operator CDNs to address this challenge, providing reports on each customer’s usage by edge location, down to the day and hour.

From there, it is merely a matter of matching MBs transferred in each record of such a report to the corresponding rate per MB. By summing the results, a CDN can calculate a customer’s total monthly charges and present it to them with full supporting data. The customer can even access this billing data through Citrix’s self-service portal, reducing the need for Content Delivery Networks to mail printed support documentation or add unneeded staff to their customer service centers.

Operator CDNs can also use a customer’s typical usage pattern to create a custom blended rate that can be applied to the content provider’s traffic across the board. Even if the CDN does not actually apply this blended rate, it can leverage the data in future price negotiations with the customer — it will know exactly how the customer’s bandwidth consumption impacts capacity planning and what a true cost-based baseline price would be. Only Citrix’s powerful multidimensional analytics allow you to combine different factors such as customer, time, geography, and network topology for such an exercise.

Citrix’s multidimensional analysis enables operator CDNs — and their customers — to dig several layers beneath the surface to precisely isolate QoS issues, accurately forecast traffic for capacity planning and to clearly identify content consumption patterns.

**Conclusion**

Citrix’s analytics and reporting can help CDNs to establish innovative pricing structures that advance their business goals.

In a hyper-competitive environment, CDNs dare not charge customers more than they should (and can justify.) Customers that contribute to improved capacity utilization in off-peak hours should be rewarded rather than penalized, as these can be the most profitable customers. At the same time, CDNs cannot fail to collect adequate remuneration from those customers who disproportionately impact the need for additional capacity and infrastructure. Allowing price structures to get out of sync with cost structures is a sure-fire way to drive those costs up.

This is particularly pertinent to telecommunications service providers, many of whom are launching their own Operator CDN offerings to reduce overall network load (and costs). The net value of CDN caching to such carriers is highest at times when load on the transport network is greatest.
True “big picture” optimization requires a broader view that examines peak and off-peak usage of both CDN equipment and network infrastructure. This calls for a pricing strategy that draws content owners to participate in the operator’s CDN but also incentivizes shifting traffic to off-peak times for the network as a whole.

Composing such a pricing scheme demands a multidimensional analytics framework powerful enough to take in not just CDN data but more comprehensive network information. To avoid cost-pricing disconnects, CDN pricing needs to better align with the true goals of peak-load pricing. This will allow Content Delivery Networks and their customers to operate with truly market-driven and optimal economic efficiency. Citrix Content Delivery Analytics can be instrumental in achieving this goal.

For more information on Citrix’s online video analytics and reporting, visit www.citrix.com.

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