

The Role of Adaptive Policy Control and Smart Caps in Managing Mobile Data Growth

- ▶ Adapt to subscriber behaviors in real-time during mobile sessions.
- ▶ Apply Smart Caps™ – precise, real-time bandwidth controls.
- ▶ Create service plans that fit your subscribers' expectations.
- ▶ Ensure fair bandwidth usage for all subscribers.
- ▶ Protect your network from traffic congestion.
- ▶ Notify subscribers about usage in real time to prevent mobile 'bill shock'.



THE MOBILE PERSONALIZATION COMPANY

Introduction

Mobile operators across the world offer a wide variety of subscription plans—flat-rate or bandwidth-capped, pre-paid or post-paid—but they are all becoming acutely aware of a worrisome trend: data traffic is growing much faster than revenues and network performance. Mobile data revenues in China and the U.S. are growing at about 50% per year¹, while Cisco Systems predicts that mobile data traffic will roughly double each year from 2008 through 2012². By comparison, the fixed Internet traffic growth rate is a steady 50% - 60% per year³.

Traffic growth is driven by a combination of new data-centric devices (i.e., iPhone, Blackberry, Android-based handsets), lower subscription costs, higher throughput, and easier access to applications and content, especially video. T-Mobile iPhone users in the UK generated 100 Megabits of traffic per month—thirty times higher than the average subscriber⁴. In the U.S., 95% of iPhone users have watched YouTube on their mobile handset⁵.

Subscribers expect to enjoy the Internet experience on their mobile devices without traffic restrictions. However, capacity on wireless networks is necessarily limited, and it has to be equitably shared among subscribers. Mobile operators face a delicate balancing act in trying to manage data traffic to avoid network congestion, and to improve the subscriber experience.

This paper discusses the challenges that the increase in data traffic poses, and how mobile operators can address them with the Bridgewater Systems adaptive policy control approach, which allows each operator to strike the right balance in managing network bandwidth resources for a high-quality subscriber experience.

Meeting the Challenge of Rising Traffic Levels

Until recently, mobile operators did not have to worry about data traffic. For many years, data revenue growth was mostly tied to SMS and email⁶—applications that require only limited bandwidth, smoothly spread over time. Mobile operators questioned whether the increased capacity of 3G networks was needed after all.

They certainly need it now, as mobile Internet access and bandwidth-intensive applications have become the major drivers for data traffic growth. At the Vodafone Group, for instance, growth in mobile data revenues (47%) far outstripped growth in messaging (15%) in 2Q 2008⁷.

Mobile operators have already started to experience network congestion as a result of the increases in adoption of mobile Internet services and in the amount of data usage per subscriber. Other mobile operators expect to see their networks running at capacity soon in their busiest areas.

One solution is to increase network capacity. Network upgrades bring some relief to operators, but they can be expensive and time-consuming—and the pace of technological innovation in network elements is not sufficient to keep up with the current rate of traffic growth. Rolling out new networks is also possible, albeit expensive, and available only to operators with additional spectrum.

Another solution is to impose limits on subscriber bandwidth consumption, often combined with additional fees for exceeding those limits. Bandwidth caps and throttling mitigate the problem by reducing the overall traffic, but they are increasingly unpalatable if used indiscriminately. If pursued aggressively, this approach reduces the attractiveness of the service and is bound to disengage current and prospective subscribers.

¹ Source: Operators

² Source: Cisco Systems

³ Source: Minnesota Internet Traffic Studies (MINTS)

⁴ Source: Deutsche Telekom

⁵ Source: AT&T

⁶ Messaging still accounts for 60% of data revenues at the Vodafone Group

⁷ Source: Vodafone Group

More importantly, however, indiscriminate throttling, and some usage cap approaches are simplistic, post-hoc remedies that punish subscribers rather than improve the efficient allocation of network resources. Furthermore, as subscribers become increasingly reliant on mobile data, they are responding to the fact that they are unaware of how their application usage and roaming behavior translate into the data charges that appear on monthly bills or deplete prepaid accounts. This is evidenced by proposed EU regulatory initiatives designed to protect subscribers while roaming abroad, and the recent class-action lawsuit in North America between subscribers and a major operator.

Current approaches do not replace the need for a far-reaching, long-term traffic and subscriber management strategy that is sufficiently flexible to adapt to future changes in network capacity and emerging subscriber usage models.

If it is not properly managed, the current growth in data traffic coupled with inadequate transparency for subscribers will rapidly become unsustainable. Mobile operators need to take a proactive role in addressing traffic growth before network congestion and subscriber frustration become an acute problems. Managing traffic and managing subscribers are two inextricable sides of a single issue, which can be addressed with a single, common policy control framework.

Managing Mobile Data Growth with Bridgewater’s Smart Caps

Bridgewater Policy Terms

Adaptive Policy Control:

Sophisticated and granular policy controls that adapt to subscriber behavior in real-time

Sliding Window:

A configurable duration of usage monitoring performed over shorter, more frequent intervals, typically measured in minutes rather than over the monthly billing cycle

Smart Caps:

Precise and timely bandwidth controls applied to subscriber behavior in real-time

Rebalancing:

The process of applying and removing Smart Caps to adapt to subscriber bandwidth consumption in real-time

Many operators apply hard caps that cut off mobile services when bandwidth quotas are reached, or soft caps that only moderate bandwidth usage during peak hours, which can result in subscriber dissatisfaction if they are downspeeded without warning. Bridgewater has developed a unique approach to managing bandwidth usage that involves the use of Smart Caps—precise and timely controls that adapt in real-time to changes in subscriber bandwidth usage during individual sessions.

During each subscriber session, the Bridgewater® Policy Controller monitors bandwidth usage using a “sliding window” that facilitates usage monitoring over smaller, more frequent intervals that are configurable based on service provider requirements. It then applies Smart Caps to control bandwidth on the basis of multiple real-time factors such as the subscriber’s current usage and roaming status, and the level of congestion in the network. If the network is not congested, the Policy Controller permits subscribers to continue to use bandwidth-intensive services, even if they have exceeded their usage quota. However, if a subscriber is using this type of service during a period of network congestion, the

Policy Controller can apply Smart Caps to re-prioritize the subscriber's access to network bandwidth resources. When this happens, the subscriber is gracefully downspeeded to an equitable level temporarily, until the congestion in the network subsides. Bridgewater's adaptive policy control approach is illustrated in detail in Figure 1.

Smart Caps are applied in real-time, reducing operating costs that are typically associated with the "needle in the haystack" approach which requires extensive offline analysis to identify high-bandwidth users, and determines how and when to impose caps.

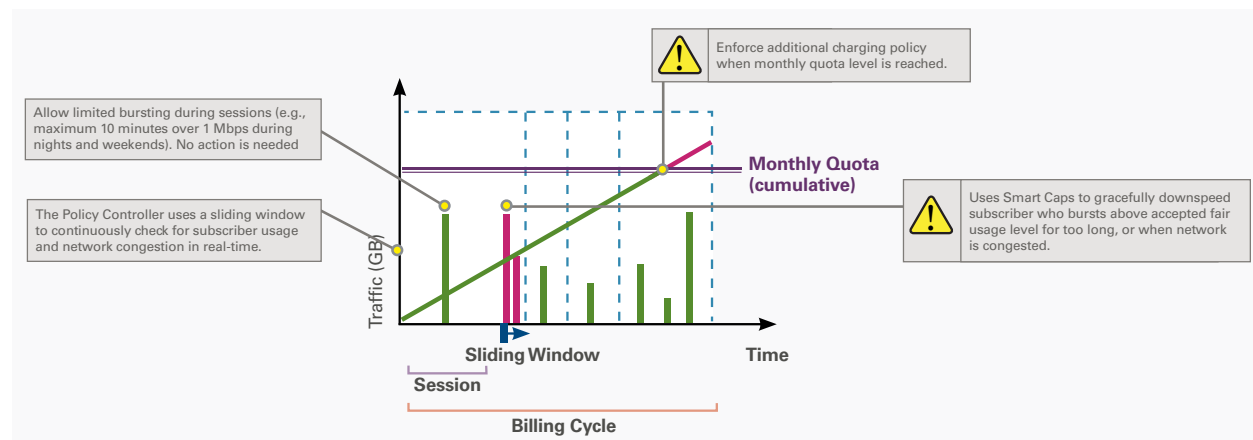


Figure 1 . Bridgewater's adaptive policy control enables operators to use real-time subscriber usage information to enforce policy.

Moving Beyond Dynamic Controls: Bridgewater's Adaptive Policy

The Bridgewater Policy Controller uses three types of policy control, which work together to manage bandwidth consumption and network resources (*Figure 2*):

- ▶ **Static policy control** takes into consideration the subscriber's context (including roaming status, device type, and service entitlements), and applies a policy that lasts for the duration of the subscriber's session.
- ▶ **Dynamic policy control** changes network settings after subscribers enable new services during a session, determines whether subscribers have exceeded their usage quota and what should be done, and establishes whether the subscriber can access an application and at what quality of service setting.
- ▶ **Adaptive policy control** rebalances access to network resources in real-time in response to individual subscriber context and behavior, as well as network conditions, such as levels of Radio Access Network (RAN) congestion and time of day. Adaptive policy control enables mobile operators to set specific network access policies for roaming subscribers —i.e., to let subscribers choose the data applications available to them while roaming.

Static Policy	Dynamic Policy	Adaptive Policy
When: at attachment	When: mid session	When: continuous, real-time
Driven by subscription plan and preferences	Changes network settings to enable new services	With Smart Caps, implements flexible charging rules based on complex dynamic, mobility-driven conditions
Defines subscriber-specific QoS, entitlements, allowances	Updates QoS, entitlements, and allowances for session	Driven by session state, roaming status, time, location, IP address, device type, access type
Terminates upon end of session		Sensitive to network context, including RAN congestion, peak/non-peak traffic levels

Figure 2 . Three-level policy model supported by Bridgewater's Policy Controller

Bridgewater's flexible and comprehensive policy control model enables mobile operators to fine tune and modify policy rules in real-time in response to subscriber behavior and the level of congestion in the network. This enables them to:

- ▶ Use Smart Caps to detect and manage bursty usage and support context-based downspeeding.
- ▶ Implement fair usage policy enforcement consistent with the terms and conditions defined in contracts with subscribers.
- ▶ Define unique policy rules for unlimited flat-rate or monthly metered plans, and pre-paid and casual-user options that rely on adaptive policy control.
- ▶ Transparently communicate the impact of policy rules to subscribers, and offer them opt-in/opt-out and service extension options in real-time, on the basis of their behavior during mobile sessions.

How Does it Work?

In a standard 3GPP deployment, the Policy Controller functions as a Policy and Charging Rules Function (PCRF). During a subscriber data session, the Policy Controller retrieves subscriber information from the Subscription Profile Repository (SPR), the standard subscriber database element specified by the 3GPP. The Policy Controller combines the subscriber information with real-time session information such as usage, location, time of day, and Radio Access Network (RAN) congestion status. Based on this data, the Policy Controller then modifies the policy rules on the access gateway depending on the type of policy control required. For example, policies can be applied for the purposes of re-balancing the network resources in a fair manner, changing the user's Quality of Service (QoS) settings due to a change in access technology, or if the subscriber has exceeded monthly service plan quotas (*Figure 3*).

The Policy Controller fully supports standards-based (3GPP, 3GPP2, WiMAX™) specifications on the policy function, but can also be deployed in proprietary network architectures, typically in conjunction with Deep Packet Inspection (DPI).

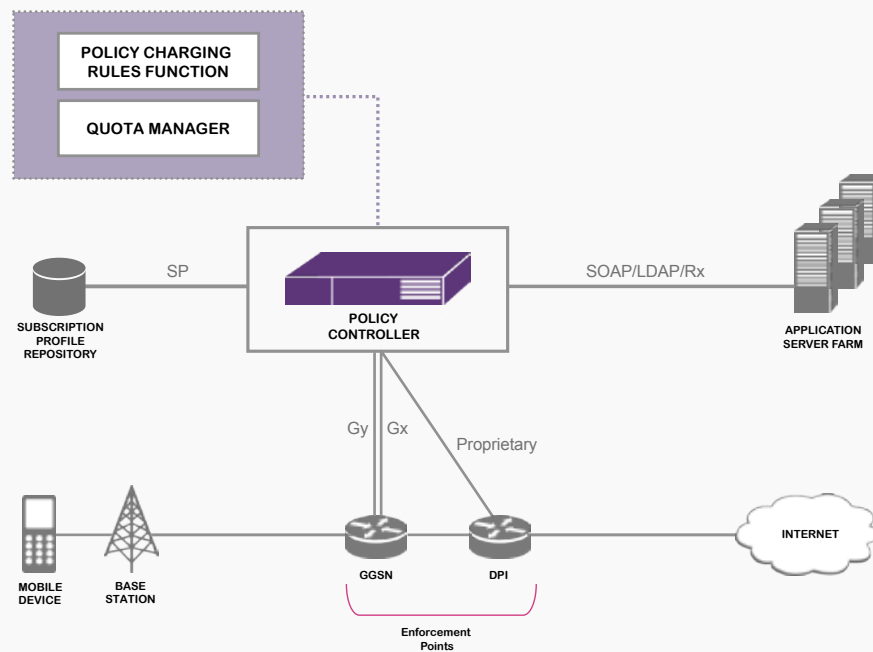


Figure 3 . Deploying the Bridgewater Policy Controller in a Mobile Data Network. The Bridgewater Policy Controller Functions as a PCRF in 3GPP standard deployments. In certain types of deployments, the metering function provided by the Policy Controller's Quota Manager removes the requirement for an on-line charging system.

A More Dependable Service that Respects Subscribers

Respect for subscribers and an improved subscriber experience are the cornerstones of Bridgewater's approach to fair bandwidth usage. The policy controls enabled by the Policy Controller are nondiscriminatory and protect subscriber privacy. These controls can be configured to monitor the overall traffic generated by the subscriber as opposed to being tied solely to specific applications.

The application of adaptive, dynamic, and static policy controls lead to a more dependable service for subscribers and more efficient distribution of network resources. It also gives subscribers access to more flexible service features. Mobile operators may offer a service plan that allows subscribers to use high-bandwidth applications (i.e., for video content) without limitation when the network traffic is low and apply limits only when the network is congested.

Context-based downspeeding also brings improved performance for the majority of subscribers, who generate moderate amounts of traffic. In most cases, they are not directly affected by downspeeding, as they do not reach their bandwidth caps or abuse the fair usage policies. Indirectly however, they benefit from the downspeeding of the small fraction of subscribers who use a disproportionate amount of the bandwidth available.

Proactive notifications on exceeding bandwidth caps, violation of fair usage policies, add-on service availability (i.e., the ability to raise the bandwidth cap temporarily), or extra charges (i.e., due to roaming) lead to an improved, more transparent relationship with subscribers. Subscribers no longer have to worry about surprise charges at the end of the month, and are able to modify their plans either temporarily or permanently depending on their needs.

Usage Scenarios

Requirements and product offering strategies vary across mobile operators and are crucial to their ability to differentiate their services and to sign up new subscribers. The Policy Controller gives operators the freedom to define and experiment with specific policies, and create flexible service plans enabled through Smart Caps and adaptive controls. The following usage scenarios provide selected examples of how the Policy Controller is being used by operators worldwide.

Post-paid Capped Plans

Subscribers often view capped plans with suspicion. They may not know how much bandwidth they use or need. They either pay for bandwidth they do not need, or reach their caps early in the billing cycle. This may result in unexpected additional charges or temporary service unavailability. With Bridgewater's adaptive policy control approach, the operator has continuous access to real-time information about the subscriber's behavior, collected throughout the billing cycle. The mobile operator can provide warnings to subscribers who are close to reaching their bandwidth caps, or offer them an upgrade to the next service tier. They can also gradually reduce subscribers' speeds, block some types of traffic, redirect subscribers to on-portal applications, or assign a new QoS level to help them manage their bandwidth consumption. Bursting access at higher bandwidth levels may be enabled for limited periods. The mobile operator may decide to make different options available to subscribers, and let them decide what works best for them.

Fair Usage Enforcement for Post-paid Subscribers on Unlimited Plans

Subscribers on unlimited plans are not subject to monthly bandwidth caps, but they still need to respect the operator's fair usage policies, which may dictate average bandwidth thresholds, with some allowances for bursty access. In this case, sustained high levels of traffic may trigger an initial notification to the subscriber and a subsequent gradual downspeeding to protect the network against abuse. The additional flexibility of this gentler approach enables the operator to distinguish between temporary, unexpected increases in subscriber traffic and network abuse.

Tiered Services

Effective market segmentation can be achieved with the introduction of service tiers that may vary in terms of bandwidth, QoS availability, download or application-specific allowances, and bursting limits (by time, volume, or both). This approach enables mobile operators to offer the highest levels of service to high-ARPU subscribers, as well as to meet the demands of more budget-conscious subscribers with fewer requirements.

Casual User Access (i.e., day pass)

Occasional use of the data network is targeted at visitors who require data access for a limited time, and at current subscribers who have not signed up to a monthly data plan. It is a service that attracts new revenues from users not interested in traditional plans. Mobile operators can increase the attractiveness of the service by offering flexible and dynamic metering (i.e., time or volume) and fast provisioning.

Pre-paid Access

Similar to casual user access, pre-paid services are targeted at users who do not want a long-term contract and have limited bandwidth needs. With a pre-paid option, operators may decide to meter access on a traffic (GB/month) or time (minutes of use) basis, and charge separately for add-on services. The cost of providing this service can be kept low, as subscribers can use the online portal for provisioning and to top-up their account (the operator can prompt them to do so when their time/traffic available runs low).

Roaming

To prevent unexpectedly high roaming charges, some subscribers may prefer being barred from all or some data applications while roaming. For instance, subscribers may wish to avoid the high cost of data services while they are outside their operator's coverage area, but retain the data service when they are not roaming.

On- and Off-Portal Applications

Operators can detect access to on- or off-portal applications, and they may choose to charge differently—or impose no fees—for on-portal applications.

Time of Day

Network usage is high during peak hours, but it decreases significantly at other times. The operator may decide that traffic generated during non-peak hours does not count towards bandwidth caps (i.e., the equivalent of free calls during evenings and weekends), or that bursty access is allowed for a longer period than during peak hours.

Network Congestion

Real-time traffic information from the network and, more specifically, from individual base stations enables the operator to identify areas of congestion within the network. The Policy Controller gives the operator the tools to contain congestion in real-time by temporarily enforcing more stringent policies (i.e., not allowing bursting behavior, or assigning lower priority to low-ARPU subscribers).

Avoid Bill Shock and Extend Control to Subscribers

Most average subscribers don't know what their mobile data consumption is or how this relates to their current service plan. Using the Policy Controller, operators can offer transparent, proactive notifications when subscribers are near fair bandwidth usage or data roaming charge limits. Subscribers can then be given choices in real-time such as a service extension, a data usage boost, a lower bandwidth service, or other alternatives. In addition, operators can extend control to subscribers to set personalized usage caps that can be updated in real-time based on personal financial limits, or to boost roaming data usage while traveling.

Conclusions

Adoption of mobile Internet services is growing at an impressive rate, and subscribers are relying on a wide range of applications, which increasingly include bandwidth-intensive streaming media applications. While this is great news for mobile operators' data revenues, the rapid increase in traffic levels poses multiple challenges. How can network congestion be avoided? What is the best way to equitably allocate network resources among subscribers, while improving the overall user experience? What are the service plans and features that will make subscribers more eager to sign up for mobile Internet plans?

Answers to these questions will emerge as mobile operators gain a better understanding of market dynamics, user expectations, and usage models. But the market is still in a phase dominated by rapid innovation in charging models and service offerings, and by continuous evolution in bandwidth management models. Mobile operators have a steep learning curve ahead and need powerful, future-proof tools to experiment with different bandwidth and subscriber management models until they find the one that best fits their subscribers' expectations and their own network resources. Bridgewater's adaptive policy control approach gives mobile operators a sophisticated and yet straightforward way to support a long-term strategy to maximize network utilization, revenue opportunity, service model innovation, and subscriber satisfaction.

Bridgewater Systems Policy Controller	
<p>What:</p> <ul style="list-style-type: none"> ▶ Policy server controlling how and under which circumstances subscribers access applications and network resources ▶ Functions in both non-standard (DPI) and standards-based (3GPP PCRF) deployments 	<p>Key Features:</p> <ul style="list-style-type: none"> ▶ Centralized policy data store ▶ Real-time traffic metering and mid-session modification of user allowances ▶ Service enablement tools, including bandwidth boosts, definition of service tiers, content-triggered QoS, casual and pre-paid access models, differentiated charging ▶ Support for 3GPP, 3GPP2, WiMAX standards ▶ Support for DPI enforcement ▶ Subscriber redirection and self-care portal to improve and simplify communications with subscriber and modifications to service plan ▶ Carrier-grade scalability and performance
<p>What is Unique:</p> <ul style="list-style-type: none"> ▶ Adaptive policy control – rebalances subscriber access to network resources in real-time in response to individual subscriber context and behavior, as well as network conditions ▶ Real-time, per-subscriber, per-session data traffic management ▶ Smart Caps - precise and timely controls that adapt in real-time to changes in individual subscriber bandwidth usage. 	<p>Bottom Line:</p> <ul style="list-style-type: none"> ▶ Intelligent control over network resource usage to optimize investments ▶ Increased ARPU and subscriber retention through service differentiation ▶ Decreased time-to-market in introduction of new services ▶ Access to third-party content and application providers without giving up control of the subscriber
<p>Service Enablement:</p> <ul style="list-style-type: none"> ▶ Support flexible, innovative service plans – while managing network resource consumption in real-time ▶ Define and enforce fair usage policies in unlimited plans – no need for costly, “after the fact” usage analysis ▶ Offer on-demand, real-time service upgrades for subscribers to bring in incremental revenues ▶ Leverage real-time metering for new casual user service models – attracts new users who want the convenience of casual access without the commitment to a long-term contract ▶ Manage roaming costs by selectively enabling access to only specific applications while roaming 	

Bridgewater Systems, the mobile personalization company, enables service providers to efficiently manage and profit from mobile data services, content and commerce. The company's market leading mobile personalization portfolio provides a real-time, unified view of subscribers including entitlements, devices, networks, billing profiles, preferences and context. Anchored by Bridgewater's Subscriber Data Broker™, the portfolio of carrier-grade and standards-based products includes the Bridgewater® Service Controller (AAA), the Bridgewater® Policy Controller (PCRF) and the Bridgewater® Home Subscriber Server (HSS). More than 100 leading service providers including America Movil, Bell Canada, Clearwire, Hutchison Telecom, Leap Wireless, Scartel, SmarTone-Vodafone, Sprint, Tata Teleservices, Tatung, Telmex, Telstra, and Verizon Wireless use Bridgewater's solutions to rapidly deliver innovative mobile services to over 150 million subscribers. For more information, visit us at www.bridgewatersystems.com.

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