THE EXPOSED HEADEND: ENABLING A STRATEGICALLY DEFENSIBLE POSTURE FOR BROADBAND TELECOMMUNICATIONS SERVICES

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Abstract

This paper discusses critical service monitoring/management challenges several MSOs are already facing, and many others are certain to encounter within the next several years. If and/or when the FCC imposes service-transport unbundling regulations on the cable industry, these challenges will immediately become industry-wide. Even absent unbundling regulations, as cable operators increase advanced telecommunications service offerings, they will eventually need to overcome these issues.

The basic services monitoring and management challenges are rooted in the shared nature of broadband delivery networks, and the lack of thorough operational information integration among back-office graphical information (GIS) and billing systems. Shared network oriented issues are further aggravated by the finite nature of bandwidth capacity allocated for advanced broadband service delivery.

In a broadband digital services environment where services are concurrently delivered, especially when external service providers are involved, asset control and service integrity (i.e., stability and consistency) complications are introduced. These challenges impose the need for an integrated services monitoring/management system (ISMS). Such a system must, among other critical functions, enable operators to maintain control over their broadband infrastructure in order to ensure the integrity of concurrently delivered services.

If the notion of an ISMS as a basic requirement does not make you uneasy, then it is likely you do not fully grasp the problems an ISMS must solve. As this paper title suggests, implementing an ISMS involves a virtual exposure of key components of the shared broadband service delivery infrastructure, as well as a dynamic proxy representation of those components. In addition, an ISMS must have dynamic access to (often-disparate) back office system databases in order to ensure service reliability and consistency. This paper explores the details of the integrated services management problem. Ideally, readers will gain sufficient insight and understanding as to why an ISMS may need to be the cornerstone of any future advanced broadband services capability.

BACKGROUND

Broadband Internet and other advanced telecommunications services are gaining momentum, and appear to be viable contenders in the race to shape the future of cyberspace. This translates directly into increased revenue per subscriber as these services are developed and deployed. (Through creative service packaging options, a portion of this increased revenue could even come from new entertainment subscribers.) Data/Internet service subscribers are increasingly demonstrating a **preference for performance** with the growing penetration of broadband data services. In fact, in most markets offering advanced broadband data services, attrition rates are approximately the same as or below the rates attributed to death and/or subscriber relocation.

It is especially interesting to note that many broadband-based data service subscribers are getting online **for the first time** (approximately 20% or so[1]), versus outgrowing a dialup connection. This speaks loudly to the convenience as well as the performance of high-speed data via broadband cable. This is the good news.

As is usually the case, success in new and leading edge businesses generally comes with its own set of unique challenges. When those businesses are as complex and dynamic as provisioning broadband Internet and all the other rapidly emerging advanced telecommunications services riding the Internet wave, some of these challenges can be substantial.

Understanding the Challenge

Subscribers appear willing to pay a premium for broadband performance only if other service attributes are at least at parity with competing services in the areas of service reliability and consistency, and customer technical support.

Effective customer support can be achieved through a knowledgeable internal and/or outsourced technical helpdesk capability. In a shared broadband network environment, however, service reliability and consistency present considerable challenges.

Service *reliability* requires broadband operators to attend to the signal quality and stability of the underlying broadband delivery infrastructure in a *proactive* manner. This means an ISMS must enable operators to anticipate and automatically respond, wherever possible, to degradations in the infrastructure that can lead to service failures. (Ideally, service-threatening conditions are remedied **before** failures occur.) However, until service-disabling infrastructure anomalies can be recognized by its correlation engines, and responded to by its automated scripts, an ISMS must enable an operator to quickly identify, isolate, and resolve, service failures.

Problem anticipation and automated response requires an integrated correlation engine that links problem scenarios with many related dynamic performance variables and conditions. Before operators can achieve an anticipatory service management posture, they need system capabilities that enable correlation functions to be developed and refined (as new problems arise) for incorporation into an ISMS. In order to do this operators need an accurate service monitoring/management capability that is granular enough to capture correlation characteristics, and responsive enough to enable timely service restoration prior to the availability of automated system response capabilities.

Service *consistency* requires operators to consider and dynamically manage the effects of concurrent service delivery on their shared infrastructures.

An Integrated Services Management System capability appears to have been largely overlooked in all the excitement surrounding broadband service performance. Absence of this capability could easily become the cable industry's Achilles heel if not addressed in a hurry.

Let us begin our understanding of what an ISMS must do by exploring the details of the problems it must solve. This is probably best done by examining the primary attributes of broadband-based advanced telecommunications services technically, as well as from the typical user's perspective.

DETAILED PROBLEM ATTRIBUTES

The current and future problems an ISMS must solve manifest in the intra-service and inter-service domains, and in the related area of integrated back-office databases (ISMS solution implementation).

Intra-service issues are introduced by the standardized capabilities of DOCSIS 1.0-compliant cable modems. To a certain extent, the introduction of DOCSIS 1.1-compliant cable modems sometime down the road will make the service consistency perception problem somewhat more manageable, in exchange for increased complexity.

Inter-service domain issues are primarily associated with the notion of external entities delivering services on cable networks. However, the eventual introduction of OpenCable-compliant set tops, incorporating any version of DOCSIS-compliant cable modem functionality, could further amplify the both the intra- and inter-service domain issues. Longer term, the arrival of DOCSIS 1.2-compliant cable modems and/or set tops could simply aggravate the problems even more.

The fundamental issues associated with an ISMS solution implementation are its need to access back-office systems' information collateral necessary to perform its functions, and the integrity of this information. This primarily billing and mapping information is essential to service outages notification, identification, isolation, and restoration capabilities an ISMS must provide. Often, the back-office systems that generate this information are not well integrated.

Reliability

In order for subscribers to consider broadband services as reliable, the availability of those services must at parity with competitive offerings. Service availability requires rapid outage awareness, isolation, and resolution. It is therefore imperative that an ISMS have access to operationally accurate information in order to facilitate quick awareness, isolation and resolution of service outages.

In most existing scenarios, however, the reliance of an ISMS on any one back-office database is problematic. (This problem might be all too familiar to many operators.) This is largely because many of these databases, although containing similar information, have evolved in support of different functions (e.g., billing and mapping), and usually under the control of different departments. In addition, a by-product of many cable system mergers and acquisitions has been the introduction of different back-office systems. In the interest of continued operational continuity during the aftermath of these mergers and acquisitions, legacy back-office systems are often left in place.

A significant aspect of building an ISMS solution will therefore be the creation of an accurate, dynamically sustained and normalized abstraction of pertinent back-office system information.

The bottom line here defines requirement one for an ISMS:

- ***Create and use a dynamically normalized abstraction of back-office systems databases containing subscriber and service-delivery infrastructure information considered critical to the rapid isolation and resolution of service-threatening conditions.***

This ISMS requirement also enables continued use of legacy systems, minimizing operational stress (i.e., staff re-training) and related disruption.

Intra-Service Issues

The primary attribute of a broadband service delivery environment is the shared nature of the transport infrastructure. Even a single broadband data service shares the transport network with entertainment programming. Unless dedicated channels are allocated for each distinct data service, multiple data services will share the same spectrum. (Recent studies[2] suggest that 18 MHz of return spectrum will be required to support all the commercial services cable operators are contemplating.)

In a generic Internet access services scenario, multiple subscribers contend for bandwidth within the channel pair(s) allocated to this service class. The access methodology inherent in cable modem solutions is designed to effectively manage the contention for this bandwidth among subscribers. However, during peak traffic periods, even this access methodology can be overwhelmed by demand, resulting in a degradation of service performance *consistency.* In today's competitive telecommunications climate, variations in service consistency are potential problems. (Subscriber perception is reality.) The service consistency issue will eventually apply to all broadband services

including Internet access, IP telephony, interactive television, video-on-demand, video-conferencing, interactive games, and so on.

With traditional telephony-based Internet services (i.e., a dedicated circuit for each user), subscribers enjoy a level of service consistency at least to the ISP point of presence (POP). This means that any content (e.g., web pages, newsgroups, files) consumed from servers resident in the POP, assuming the server platform is sufficiently performance-scaled to meet anticipated concurrent load, will be delivered in a fairly consistent manner. (Of course, if the content being consumed is beyond the ISP POP, and especially if it must transit one or more Network Access Points (NAPs) in route, performance inconsistencies are introduced.) However, in apples-to-apples comparisons to circuit-based competitive offerings, a disparity in service performance consistency represents an exploitable weakness. Inconsistent service performance is the first cousin of perceived service reliability. (If the time it takes for your lights to come on varied noticeably by time of day (i.e., subscriber load), how reliable would you perceive your utility service to be?)

Of course the answer to performance inconsistency in a shared network environment is to increase the available bandwidth proportional to the offered load. This can be accomplished via node splitting or simply by devoting more spectrum to data services. Both of these solutions have an associated cost in equipment or loss of revenue previously attributable to re-allocated capacity, or both. (And unless you are using wave division multiplexing (WDM or DWDM) or other fiber-sharing approach, node splitting will consume lots of fiber. Perhaps someone will invent a smart fiber node, with built-in, appropriately scaled CMTS, access router, and neighborhood-sized server, that is capable of taking advantage of fiber-sharing technologies.)

The bottom line here defines requirement two for an ISMS:

- ***Monitor perceived data services (minimizing bandwidth consumption in doing so) well enough to anticipate necessary bandwidth increases in order prevent performance inconsistencies.***

Ensuring the ability to effectively deliver *different* qualities (i.e., classes) of services, among other things, is the essence of DOCSIS 1.1. This emerging revision to the DOCSIS standard should go a long way towards managing perceived service consistency in a broadband environment. However, when all is said and done, the consistency problem will likely only be compounded. In fact, with DOCSIS 1.1-defined bandwidth guarantees for different service classes, service inconsistencies will likely surface sooner as bandwidth is being consumed by the service architecture...whether or not a user is present in the equation. (A QOS guarantee is just another way to spell "circuit", even though it may be a virtual one.) Guaranteed throughputs and latencies associated with various QOS-based services will further stress available bandwidth.

The addition of QOS capabilities defines requirement three for an ISMS:

- ***Monitor perceived data service consistency across and within multiple service classes (again, minimizing bandwidth consumption in doing so) well enough to anticipate bandwidth increases necessary to prevent performance inconsistencies.***

The service consistency issue may seem to be a minor problem to many cable operators. Unfortunately, service consistency *is* a very real concern. The online community is a vocal one. If you believe subscriber comments like "cable modem service is great...when it works" will help facilitate your penetration goals, then you can probably ignore most of the above. I suspect that most operators would find such comments quite troubling, especially after investing all that capital just to enter the hot arena of intensifying telecommunications services competition.

The complexities of maintaining service consistency are amplified in the inter-services domain. Let us move on to explore the interesting implications associated with the inter-services domain of broadband networking.

The Inter-Services Domain

A few large cable operators have already encountered the challenge of delivering advanced telecommunications services from external entities. If and when unbundling regulations (i.e., separation of service from broadband transport infrastructure) are imposed on cable operators, then the entire industry will very likely come face to face with this issue in short order. Probably the easiest way to make the fundamental points here is to speculate on the nature of an unbundled cable industry environment. Whether operators proactively allow external service providers access to their networks, or the FCC imposes access, the problem is essentially the same, as is the solution. The hypothetical post-unbundling scenario presented below should emphasize the critical nature of the inter-services problem domain.

It's the day after the FCC imposes unbundling on the cable industry. Your phone rings persistently for most of the day. You hear from the likes of AOL, Mindspring, Earthlink, Prodigy, and several local garage-shop ISPs. (You may even hear from players like Lycos, MSN, and eXcite.) They all want to know when they can arrange access for access to your broadband in order to reach subscribers over your network. All but the local ISPs probably have exponentially larger budgets to spend on data services (including advertising, applications, and so on) than you do. Even if the FCC was generous to cable with any access pricing guidelines, your worst nightmare is about to begin.

Not only do they want access to your network, all these providers want access to the various gadgets that *control* how data services are delivered on your network! And if you deny them this access, they will all cry foul to the regulators claiming you are denying them the kind of access they need to deliver competitive services. (I told you it was a nightmare.) Precedence for this already exists...the competitive local exchange carriers (CLECs) and long lines players are already using this line against incumbent local exchange carriers (ILECs). Your new job: "Broadband Infrastructure Referee". So how do you cope?

ISMS requirement number four:

- ***Expose manageable service delivery components of your broadband infrastructure to external service providers, through an operator-controlled proxy function that relies on the database defined in requirement number one.***

(This is much easier to say than to actually do, as we will see in the next section.)

The exposed infrastructure will likely include cable modems (CMs), CM termination systems (CMTS), cable set top devices, network interface units (NIUs), bandwidth, data switches, routers, DNS servers, and so on. In essence, all shared manageable components involved in service delivery will need to exposed.

In case you are wondering what rationale these invaders will use to argue their cause, a few immediately come to mind. The simplest argument would be that they need access to the QOS controls of your cable modem solution. They need this access (say, tomorrow at 2:00 PM) in order to facilitate a value-enhanced commercial video conference they've sold to a few of their corporate customers. Equally plausible would be that they need to fool around with your router configuration (yikes!) in order to facilitate some multicasting monstrosity in which they've recently invested the equivalent of your entire current year data services budget. Of course, there will also be all those content-specific players that need to reserve streaming audio and video bandwidth so they can broadcast a live concert of some unknown rock band to all the kids. Speaking of kids...those interactive games can sure chew up the spectrum can't they? Since we are just speculating, you can not leave out the interactive TV stuff the networks are planning. Depending on how attractive those FCC access-pricing rules are, you may still need to be in there yourself with your own suite of cyber thrills. Enough said?

While it is true it may be some time before the imposition of such a scenarios on cable, it

could take considerable time to develop and perfect an ISMS with an acceptable "referee whistle" capability. Before we get into the primary ISMS implementation challenge, let's see if what kind of impacts OpenCable and DOCSIS 1.2 devices might have on any of this.

OpenCable-compliant set tops are supposed to include an imbedded DOCSIS cable modem function. It seems reasonable to assume that the primary drivers behind this feature are to leverage existing standards-based technologies, as well as enable in-channel compatibility between DOCSIS cable modems and OpenCable set tops. It seems equally reasonable to assume that OpenCable set tops will deliver applications focused on the interactive television as the viewing medium or service portal. Since no one company seems to have the where-with-all to do everything (not even Microsoft), it seems logical to expect that there will be different service providers attempting to leverage these different portals. And since the portals (DOCSIS CMs and OpenCable STBs) are supposed to have in-channel compatibility, it's almost assured they will be sharing the same data channels in some systems. This model sounds much the same as the external service provider scenario in an unbundled world, with the added consideration of introducing new interactivity dynamics.

DOCSIS 1.2-compliant devices are expected to employ a physical layer technique known as synchronous code division multiple access (S-CDMA), or something similar. This spread-spectrum technique is designed to improve portal device tolerance to a variety of broadband network anomalies (e.g., ingress, microburst noise, poor C/N ratios, and so on) while maximizing the number of concurrent data streams possible. A primary expectation of this future revision to DOCSIS is that it will enable a larger percentage of existing cable plants to carry data services. The expected physical encoding technique will enable greater flexibility in trading off spectral efficiency for increased throughput. DOCSIS 1.2-compliant products will not ease requirements for an ISMS, and in fact, may only increase the number of concurrent data channels requiring management.

GENERAL IMPLEMENTATION CONSIDERATIONS

It is probably useful to approach implementation of an ISMS by considering it within the context of a Network Operations Center (NOC).

NOC vs ISMS

A NOC is for the traditional monitoring, troubleshooting, and managing of network infrastructure, including key functional transport components residing on the network (e.g., routers, switches, hubs, and so on). A network operations center typically contains a suite of technology, both hardware and software, designed to assist network engineers in maintaining a reliable networking environment. A NOC generally contains systems that monitor various components of a network, enable manipulation of those components, sense general service-threatening conditions, and help isolate (and possibly resolve) problems that are discovered. NOCs are necessary for a variety of reasons. The complexities of the underlying technologies, and the number of companies and offerings (e.g., circuits and devices) involved in maintaining a sophisticated network, are good examples.

An ISMS, on the other hand, focuses on ensuring the reliable delivery of multiple services in a shared network environment like broadband cable. It is focused on those contentious aspects of shared-infrastructure service delivery, and individual service consistency, that a traditional NOC does not address. An ISMS should not be viewed as a NOC replacement, but rather as an extension to a NOC.

There will obviously be the temptation to share systems infrastructure between a NOC and an ISMS. This option must be thoroughly investigated, as an ISMS will exhibit much greater probing granularity and frequency than a traditional NOC.

Consumption of revenue-generating service delivery bandwidth should naturally be minimized in any ISMS implementation. This will require a balanced use of out-of-band and in-

band capacity to feed correlation functions, probe for performance-related statistics and conditions, and/or to impose configuration changes or other controls necessary to maintain service integrity (reliability and consistency).

An ISMS should be considered as early as possible in the planning of broadband data services deployments. This is because the capabilities of your ISMS will likely govern the number and nature of service policies than can be supported.

SUMMARY

Service management systems for advanced telecommunications services represent capabilities for which the cable/broadband industry has not traditionally had a significant need. In the existing industry environment, most cable operators can still get by without such a capability due to focus on a single data service offering. However, cable/broadband operators allowing multiple concurrent services to be delivered over their networks, especially if from external service entities, probably wish they already had an ISMS.

In a shared network environment where finite capacity is allocated to the delivery of advanced digital broadband services, the potential exists for service consistency to be at the mercy of the collective subscriber community's online behavior. When folks get online, what they do once online, whose content do they consume and where do they consume it from...all these online behavior attributes will affect the consistency of services in a shared network environment.

While it is true that the Internet is a shared network (it's actually well over a million interconnected networks), Internet access is only one of many advanced digital broadband services the industry is contemplating, and in some cases, actively deploying.

As the cable/broadband industry evolves, especially in the digital/data services arena, new service management requirements will accompany service introductions. Sooner or later, broadband operators will need the ability to expose (and manage the exposure of) key service-delivery components to the outside world. When that time comes, they will need an ISMS in order to ensure the basic functionality, quality, integrity, and performance consistency of those services. A good ISMS appears to be an essential enabler of a strategically defensible posture for advanced broadband service providers.

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[1] Based on feedback from four well-known broadband data service providers.

[2] Courtesy: Digital Furnace Corporation