THE TRIPLE-PLAY NETWORK PLATFORM

Ran Oz
BigBand Networks, Inc.

Abstract

The convergence of cable services towards IP has been an evolution in multiple steps building upon each other. IP technology is of course end-to-end for high-speed data services, is increasingly driving network transport for all services and media, and is keying the industry's expansion of voice offerings. There are serious plans in place for increasing the relevance of IP to video as well, even in the home.

The author proposes the emergence of a new triple-play platform that consolidates all processing and communications functionality required for video, voice and data services, by combining the best elements of headend video services platforms and DOCSIS cable modem termination systems (CMTSs). This platform will be standards-based with particular proficiency in IP technologies, but also support for legacy services and devices maintained in the network. The platform promises to key the emergence of far greater service functionality and resource efficiency, and boost the cable industry's competitiveness, propelling it towards being the leading provider of all services and media to its subscribers.

TRIPLE-PLAY SERVICE NETWORKS

Operator Competition

The operators of different types of access networks including cable, telecommunications, wireless, and satellite, all face steep financial pressures. They are expected to leverage the investments they've made in their plants by increasing subscribership and expanding revenue streams.

It is inevitable that operators will pursue growth by confronting each other and expanding into what had been each others' legacy businesses. In cable's case, operators are engaged in competition with satellite and telecommunications entities to sustain leadership in video and high-speed data services, respectively. And, cable is expanding its competitive sphere with its voice-over-IP efforts, while, at the same time, rural carrier experiments and fiber access planning by larger carriers indicate the coming intensification of video competitiveness by telecommunications operators.

As each type of operator pursues all growth opportunities, they evolve towards being complete providers of video, voice and data triple-play services, which leads to further advances by emerging innovative services that combine use of the different media. Subscribers have indicated a willingness to accept all electronic services from a single access network and service provider, especially if it holds promises of lower overall costs, functional enhancement and more convenient, consolidated billing and customer care.

Subscriber Diversification

The subscribers to access networks are ushering in the triple-play era by exhibiting interest in diversifying their media consumption experiences. The last few years have seen music go from physical constraint on CDs towards portable MP3 files used by the same person on an array of storage media and personal devices; gaming on both PCs and dedicated consoles move towards wide area connectivity including voice chat among

players; and increasing numbers of viewers liberating their television watching from program schedules with time shifting achieved by VOD and DVRs.

Subscriber empowerment trends are proceeding to increasingly address the long-considered question of whether the natural domain for all content and services is the television, the PC, or one for certain applications and the other for others. The long-held stereotype of the TV for "lean back" consumption and the PC for "lean forward" is now being challenged. Some subscribers might prefer one of the devices for all media, whereas for others their preferences vary with time.

PC video might be the right medium to accompany routine PC-based tasks like checking email, whereas the TV suits family viewing. Likewise, while the PC is suited for intensive data consumption, viewers are increasingly accustomed to accessing program-relevant data by EPG on TV, and other information, like full cast and crew listings for movies or statistics for sports is a logical extension, and is consistent with many people's conduct on an Internet-connected PC simultaneous with watching TV. Personal mobility brings into play even more considerations of devices for subscribers, who become increasingly empowered to drive their own experiences.

Cable Positioning for Triple-Play

With video and high-speed data leadership and good empirical evidence on capabilities to market voice, the cable industry has strong prospects to flourish in triple-play service competition. Advantages include the technical combination of a high bandwidth access medium along with the networking sophistication of the addressable headend-hub-node hierarchy.

This puts cable in good stead to leverage already-made plant investments versus telecommunications handicaps in access bandwidth, and thus richness of media carried, and satellite challenges in two-way addressability, and thus the personalization and interactivity of applications.

Another key element positioning cable for triple-play success is the industry's effective implementation of various standards to assure interoperability among components and enable the emergence of specialized best-of-breed vendors. Several still-proprietary domains remain, as in video conditional access, but the embracing of DOCSIS, PacketCable, MPEG-2 video over MPEG-2 transport, and MPEG over Gigabit Ethernet for VoD, have spurred a more innovative industry providing more choice and richer experiences to subscribers.

INCREASING ROLE OF IP IN CABLE

IP for All Media

IP's role in cable is well established for cable modem Internet access. The industry developed DOCSIS to further standardize the offering, which led to ubiquitous availability, rapid subscriber growth, and open entry by vendors of a range of innovative hardware, software and service offerings

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DOCSIS 1.1's quality-of-service provisions have sparked cable activity in voice over IP. Subscriber interest in the service is also keen, given promise of reduced costs and expanded functionality, while maintaining the quality and reliability expected of voice service.

To this point, video has been the one medium over cable least palpably touched by IP protocols. However, on closer inspection, cable has begun to realize the benefits of IP for video. Consolidation has expanded headend service areas, in terms of both population and geography, and transport between facilities has

been key. This had been previously done by legacy protocols for video sensitivity considerations, but development of robust de-jittering algorithms has enabled UDP/IP video over Gigabit Ethernet to be used for transport between facilities, even at long distances.

Gigabit Ethernet transport has multiple benefits for video, most especially the continuing steep downward sloping of the technology's cost curve, and the scalability enabled by optical multiplexing and faster Ethernet protocols. There is also an advantage gained in efficient plant management as voice and data IP services are also commonly carried over Gigabit Ethernet. And, Gigabit Ethernet's IP functionality can be leveraged, as in gauging video at the transport destination, and if there are problems with availability or quality, seamlessly switching by Gigabit Ethernet to an alternative source location.

While IP has yet to move beyond the transport network for television consumption of video, DOCSIS-driven video is also promising. Major League Baseball has demonstrated the viability of premium video offerings to the PC with its providing access to any game for a subscription. The Internet-accessed *MovieLink* offering from several major studios also commands attention of cable operators considering the availability of titles for their own TV-centric VOD services.

The diversification of cable data services to different speed tiers increases the imperative for more compelling video content available to PCs, in order to justify the subscription expenditure. IP video access also democratizes video production, as people can post their personal clips online for friends and family, or even to try promoting more broadly.

Remaining Convergence Hurdles

While data-to-television and video-to-PC services are becoming increasingly available, it still remains the case that different devices are predominantly utilized to access particular media and services. Broadcasters desire control over branding, advertising and access and litigiously resist any attempts for their content to move to the PC domain. Interactive television struggles that go back over a decade indicate difficulties that few are prepared to confront in order to bring data to the television, especially when emerging, primarily-video services like VOD and HDTV are providing new growth.

Upstream of the client access devices, convergence also has yet to meaningfully impact the cable transmission plant either. Once content arrives at distribution hubs by converged transport networks, the different services are still de-multiplexed from each other and each session is delivered to the resources and spectrum permanently (and consequently, inefficiently) assigned to it. High speed data, video broadcasting, VOD and other services are assigned to their permanent resource and frequency homes, and IP and MPEG-2 content never co-mingle in the same portion of spectrum.

This arrangement has ever-harsher consequences with increasing variety of services available over cable. Finer and finer assignments are made for nichier services, and there is a high likelihood that when traffic is high, there is excessive demand for some offerings (ex: popular, newly available VOD titles) at a time when it's lower for others (ex: little voice traffic late at night).

Such phenomena can create denials of service or compromised quality of service, concurrent with poor spectrum utilization. It drives the ongoing consideration of more plant upgrades and other intensive capital expenditure initiatives despite the competitive advantage cable should have in bandwidth availability. More dynamic allocation of spectrum to demand, perhaps through more

convergence of video, voice and data increasingly utilizing IP, promises to remedy this.

Cable Initiatives

Cable's long-standing innovative history is currently in a particularly rich period of advances across a range of services driven both by the industry as well as by subscribers. Digital video recording is progressively altering how television is watched and enhancements to this service are coming along, such as multi-room provisioning throughout the home from a single device. DVDs, home video and digital photography drive multimedia PC purchases, which themselves are increasingly engineered to act as server for multiple devices, including televisions. And this is also a trend in which cable is involving itself, as a consideration of the CableHome initiative.

PacketCable is expanding the industry's device activities towards more involvement with telephones. Within this, PacketCable Multimedia expands the leveraging of DOCSIS 1.1's quality of service for IP content from voice to greater overall richness and interactivity, including implications for gaming.

And the industry is also considering the use of IP for video, even to televisions, by leveraging the installed, expanding and improving DOCSIS infrastructure. MPEG-4 and related encoding techniques may become the next method of digital video broadcasting and other video services, with better device economics, enhanced even more by the techniques' bandwidth efficiency gains over MPEG-2.

Interest is increasing in the DOCSIS set-top gateway, or DSG, which could further improve economics and out-of-band spectrum efficiencies by consolidating all tuning to DOCSIS, receiving video compressed by advanced encoding, and transmitting upstream to the plant, both over IP. This will require headend equipment that delivers content to all video clients, beyond the scope of just the traditional set-top box.

The proliferation of IP technologies from transport to transmission network and through to the home devices is beginning. Yet the legacy installation of MPEG-2 equipment throughout networks and homes, and the high investments made, necessitate that they and their associated techniques be maintained, even as IP spreads further. The carriage of content and services MPEG-2 and IP formats presents key management and efficiency challenges that must be addressed through networks that are more flexible, intelligent and powerful across all media, while enabling increasing leveraging of IP's inherent advantages over time.

TRIPLE-PLAY NETWORK PLATFORM

Accruing IP Advantages

As cable operators expand their use of IP, further potential advantages arise. For example, UDP/IP over Gigabit Ethernet is already commonly used for the scalable pumping of content from VOD servers, and further IP evolution could lead to use of the protocol end-to-end for VOD, resulting in more server and equipment options emerging from the open standards orientation.

XML is an IP technology that determines and utilizes profiles of subscribers, content and other relevant entities. This could flexibly set profiles on access rights to premium services or pay-per-view / VOD sessions. XML parsing and data transformation techniques spawned by its Internet origins can be carried into the

cable subscriber management space, allowing access, visibility and manipulation of information in a way that was previously cumbersome or unenvisioned.

In addition to operator cost savings, subscribers also can benefit from more IP utilization. Some might desire more high performance gear that provides storage and advanced functionality locally while others may desire least expensive, or most portable, customer premises equipment that leverages the service functionality occurring upstream in the network. And subscribers might switch among methods including alternating television and PC consumption of video depending on their situation at a moment.

This diversity of access methods could benefit operators too. As subscribers take more control and responsibility over what they use to access services, they are increasingly likely to take retail ownership of their own devices for this access, and to alleviate operators from current lease arrangements, which bear expensive amortization consequences.

Subscribers diversify the services they access, the media within those services, and the devices they use. Doing so is facilitated by expanding IP utilization and empowerment of the network. Overall benefits are accrued by both the cable network operators and the subscribers they serve.

Responsive Network for IP Triple-Play

Key to emergence of a triple-play network for all media, all services and all devices is the emergence of an intelligent network platform that combines switching and routing with intensive media processing. This platform should be IP-based to take advantage of the protocol's accruing advantages, but also capable of supporting MPEG-2 and other legacy techniques, to assure that transitions are economical and manageable.

Such a platform can terminate distant or local Gigabit Ethernet links feeding content, and when located at the edge, perform QAM modulation for the accessing subscriber device. At first this could be done in separate QAM outputs for MPEG-2 versus DOCSIS, but these can be combined over the same QAMs. Dynamic downstream spectrum allocation between MPEG-2 transport and DOCSIS, as well as with other service, will allow the operator much more efficient use of spectrum. Trends towards lower cost, lower power, higher density edge QAM technology can be leveraged over DOCSIS and for all services. The inefficiencies of fixed channel allocation by service are overcome.

The resource allocation to achieve any service is simplified on a network employing the triple-play platform. Communications, media processing and physical transmission elements are consolidated in this platform. They are programmable and incrementally available as open pools of resources, to any requiring service, so that those services are deployed with much less pre-set vertical integration of functionality. They can be launched without necessity to precisely plan for take rates, creating risks of wasting resources or exhausting capacity.

A network deployed with all-IP equipment, centralized by the triple-play platform, becomes much more capable of management by highly proven techniques such as SNMP. The platform can also integrate openly into back office and customer relationship software packages to simplify and automate management. Best-of-breed OSS tools that may currently provision cable modems will be able to provision set-top boxes and other future client access devices.

More use of IP also advances better resource management through to customer premises equipment. The network can monitor

devices and download necessary capabilities to maintain manageable subscriber environments.

Improved Efficiency

The triple-play platform will combine the best elements of headend digital video platforms and CMTSs to maximize the efficiency of a cable plant that drives increasingly personalized and high quality content. For example, agile transcoding capabilities could allow all content to be accessed from a single source, and adapted on the platform for any subscribing device.

Another technique which could conserve bandwidth through the triple-play platform's support, is extending RateShaping techniques for bit rate adaptation of video streams to any format or service. Currently this technique is only economically applied to live broadcast content (in which one stream goes to many thousands of subscribers), but with hardware and algorithmic improvements, it should be applicable to any video content, whether live or off of a server, broadcast or unicast, SDTV or HDTV, MPEG-2 or IP. Bursty, best-effort data traffic is ideal to be statistically multiplexed together with variable-bit video streams in order to maximize capacity utilization.

A more IP-controlled plant can dramatically liberate conditional access to all of these types of content. Established IP techniques like RSA key exchanges can be efficiently performed as another boost to plant performance. Authenticated firmware downloads to end-user devices assure long lives and reduce requirements for expensive field visits by the operator. Over time, necessary functions like decoding schemes can be configured from the network.

More resource efficiency gains can be achieved by output QAMs that dynamically allocate their use to any service in demand at the moment to dramatically boost plant bandwidth efficiency. This can extend to having bandwidth available for commercial data and voice services during business hours and then for various sorts of home use during evenings and weekends. IP's power and emerging DOCSIS controls can also dynamically balance the allocation of upstream ports to downstream ports, which can become very valuable in consideration of trends like peer-to-peer traffic and multiplayer gaming.

Consolidation of switching and media processing for all services on the triple play platform also can enhance the efficiencies associated with enhancement of service reliability. Powerful flexibility of the platform's components means that N+1 redundancy schemes, available to any service, can be achieved within the platform very economically. One spare resource could apply to any service, rather than having spare resources within each one.

An intelligently designed triple-play platform can itself be a seat of complete deployment efficiency, by disaggregating its three basic stages of functionality: ingress processing, Ethernet switching and egress processing. Each of these can be scaled in isolation so that the network's resource allocation conforms to exactly how it's used. And each can be modified in isolation as well, by software upgrade or modular expansion when possible, generally without disrupting investments in the other elements. For example, a non-blocking Ethernet switching fabric can be enhanced for continuing improvements in speed, scale and reliability, while preserving investments already made in well configured ingress and egress resources. Or, at egress over time QAM technique could be modified from 256 to 1024 while preserving the other two stages. Downstream, upstream and processing enhancement can be

by simple blade addition as required to better fit the specific areas' traffic needs.

Functional Enhancement

The triple-play platform as an anchor for more IP deployment generally throughout the network facilitates ongoing enhancement to the service functionality available. An early illustration, achieved differently, is in the current collaboration between satellite and telephony operators that displays incoming caller ID to the television set. All-IP networks can do this even more robustly, able to distribute such information to any connected device in the home. Viewers could use the open standards and rich functionality available on their television and/or its associated devices to browse any information from the Internet that's relevant to what's being watched. And interaction no longer needs to involve the disruption of picking up a telephone – remote controls or other devices can drive ordering something that's advertised, or voting on a reality television show. From the network side, IP-related standards like IP MAC addressing could better personalize distribution, as in a demographically oriented, precisely targeted advertisement, with anonymity maintained.

New services can be rapidly launched and experimented with, either throughout the operator's network, or by the subscriber in the home. These can be dynamically scaled up if popular, or down if not. Video conferencing, unified messaging and telemetry are examples of new services, driven through a triple-play platform infrastructure on which cable operators could enhance subscriber loyalty and drive new revenues.

Overall, a more IP network driven through a triple-play platform, vastly expands functional possibilities for subscribers. This is largely, but not exclusively, driven by the operator's own services that it makes available. There is also an attractive democratization in that subscribers can leverage open, available protocols to set their own service environments, including retail-purchased elements, and even embark on their own service provisioning towards other subscribers, in partnership with their cable operator

AUTHOR CONTACT

Ran Oz
Chief Technology Officer
ranoz@bigbandnet.com

BigBand Networks, Inc.
475 Broadway
Redwood City, CA 94063
650 995 5000
http://www.bigbandnet.com