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WHITE PAPER

Digital Simulcasting:

The Next Critical Step in the Move to All-Digital

Abstract

As the competition for the delivery of broadcast video to consumers heats up, cable operators plan to ensure that they stay ahead of the curve by offering the most advanced video, voice and data services available. While a move to all-digital networks would increase network bandwidth and allow cable operators to fully optimize their network architecture, it is not a move that can be accomplished overnight, and it will require a well designed plan. The architecture that provides the smoothest path for the transition is digital simulcasting. This paper explains the concept of digital simulcasting, describes how the move to a simulcast environment facilitates and accelerates the cable industry's eventual transition to all-digital, and details how RGB Networks' offering for high-density edge decoding and NTSC modulation in a digital simulcast environment helps simplify and accelerate the migration.

The Best Step Forward

The cable industry is moving fast to offer new technologies and services such as Video-on-Demand (VOD), high-speed Internet access and Voice-over-IP (VoIP). These advanced services will help operators to boost customer satisfaction, reduce customer churn and to compete favorably with both existing competitors, namely the satellite television providers, as well as with upcoming competitors, such as the regional telephone companies who plan to offer video services. To deliver this wide array of bandwidth-hungry services, cable operators must find ways to reclaim bandwidth, which can be accomplished with the deployment of all-digital networks.

However, there are major risks to carrying out the transition to all-digital networks too quickly. An overnight shift to all-digital could cause massive disruptions to cable operators and subscribers alike because of the need to upgrade all subscribers to a digital service. The cost of the digital set-top boxes alone would be staggering, but in addition, some subscribers just do not want to switch. A large population of analog subscribers is satisfied with the basic service they receive today and have no intention of moving to digital cable in the near future. A sudden switch to all-digital could also wreak havoc with the local cable advertising business because different ad insertion gear and technology are required for digital programming. A slower transition can significantly reduce these problems.

The best approach is to make the transition in steps. One large step forward in the transition to all-digital is the implementation of a digital simulcast architecture, which enables cable operators to offer new services to digital subscribers while continuing to meet the needs of current analog subscribers.

Defining Digital Simulcasting

In a digital simulcast environment, cable operators use digital encoders to encode and convert all analog programs to digital at the headend. The encoded programs are then multiplexed and sent along with the existing digital channels throughout the network to the network edge, also known as the hub or local headend. At the edge, the digital content is decoded, NTSC-modulated and upconverted to deliver an analog program line-up for the analog subscribers without the need for a cable set-top box, while digital subscribers receive a fully digital program line-up, not just those channels offered on digital tiers, enabling them to enjoy improved picture quality.

With its many advantages, digital simulcasting provides the logical next step that the cable industry needs to make its long-awaited move to all-digital networks, enabling a smoother transition for both operators and subscribers. As more analog subscribers shift to digital service, cable operators can gradually eliminate the older analog distribution equipment in their networks. They can also replace the remaining hybrid analog/digital set-tops in subscribers' homes at a steady, controlled pace and take advantage of digital-ready television sets with secure CableCARDs and more efficient all-digital set-top boxes on their own schedule. Cable operators can also benefit from the lower price tag of the new digital-only set-top boxes which cost less to produce, deploy and maintain.

The Case for the Move to All-Digital

Cable operators' keen interest in all-digital is spurred by their desire to liberate bandwidth for the delivery of advanced services that will help to attract and retain subscribers and generate new revenue. In a typical 750 or 860 MHz cable system, an 80-channel analog line-up occupies nearly 500 MHz of spectrum, enough to carry several hundred bandwidth-efficient digital services. In fact, cable engineers believe that digital carriage can produce more than 10 to 14 times greater bandwidth efficiency than analog carriage. By eliminating the analog channels, cable operators can gain back nearly 500 MHz of spectrum, or more than half of their total spectrum, for other uses.

With their reclaimed spectrum, cable operators can more easily add such growing, bandwidth-intensive, advanced video services as VOD, high-definition television (HDTV), interactive program guides, network-based Personal Video Recording (nPVR), and interactive television. They can also devote more channel space to high-speed Internet service, boosting upload and download speeds and adding new multimedia applications. In addition, they can dedicate more spectrum to such promising new products as VoIP and on-line gaming.

But, the benefits do not end there. The additional bandwidth also allows cable operators to advance towards a truly switched, On Demand environment.

Figure 1 shows an example of a fully digital cable frequency plan. As shown in this figure, up to 83 additional 6 MHz channels are freed as a result of the digital conversion. Assuming an average of 14 streams per 6 MHz channel through statistical multiplexing of digital video services, this equates to 1,162 additional video streams. In a typical cable system with 500 homes per node, and with an average of 2.3 televisions per home, operators can deliver a true switched digital video service and offer Everything-On-Demand (EOD), as well as nPVR services to each home and every set-top box. As a result, viewers gain the freedom to watch what they want, when they want it.

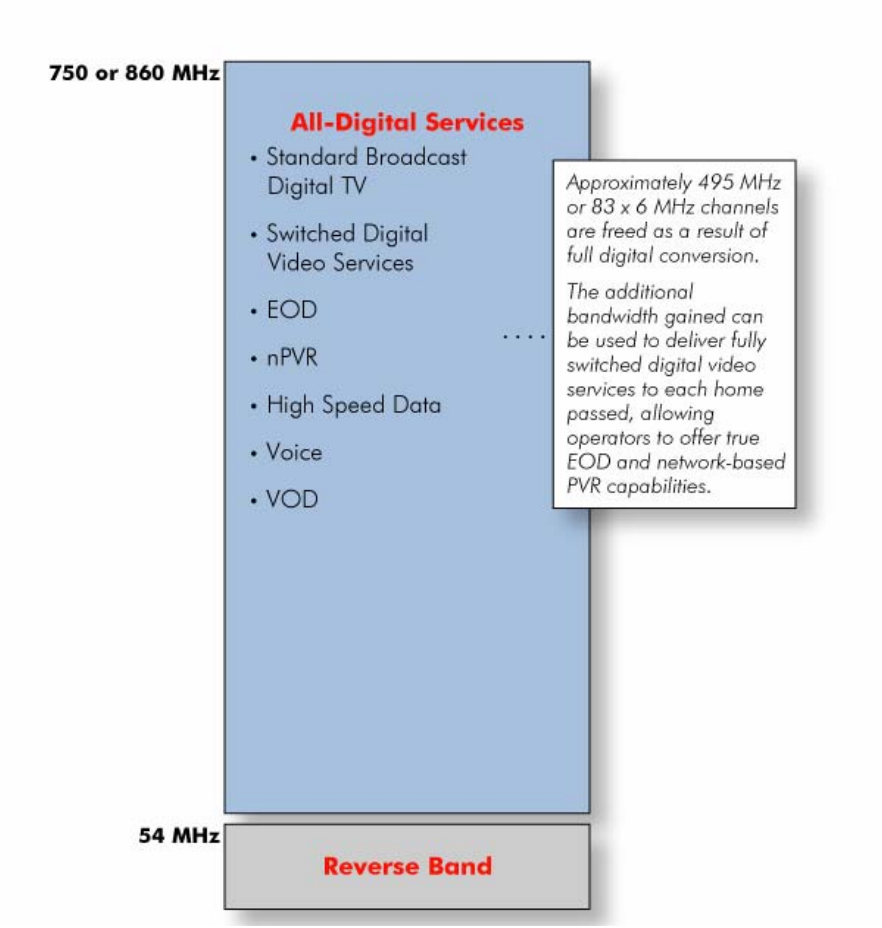

Figure 1: Frequency allocation in a fully digital cable system

With all-digital transmission systems, cable operators can also offer improved picture and sound quality to all subscribers. Because each channel is converted to digital at the headend and then carried throughout the network in digital format, cable subscribers receive all of their programming in superior digital form, not just the digital-tier services. Viewers no longer experience two different levels of video and audio quality.

As a result, cable operators gain marketing parity with satellite television providers, who have been trumpeting their "all-digital" services for years. Cable operators could rightfully make the same claims to full digital quality, helping them to attract more consumers, cut monthly churn rates and minimize subscriber losses to satellite and other alternative video service providers.

Furthermore, the adoption of all-digital systems significantly reduces set-top box and other capital costs for cable operators. Without the need for the costly analog tuners and conditional access systems of today's hybrid analog/digital boxes, set-top manufacturers could produce simpler, less expensive all-digital set-tops for cable operators to buy and deploy. The savings would be even greater for the new DVR-capable digital set-tops because they can store digital content on disk without having to encode the content first. In addition, the traditional optical equipment used to carry analog video over fiber backbones would no longer be necessary.

However, the move to all-digital can't happen overnight. To avoid the disruption of a singular, massive switchover, operators must follow the right steps. Digital simulcasting, when executed right, promises a smooth, controlled path to the eventual all-digital goal.

Digital Simulcasting: An Array of Benefits

The move to all-digital transmission between the headend and hub simplifies the cable architecture and eases the eventual shift to a completely digital network. When cable operators are ready to move to all-digital, the network upgrade would only involve the replacement of the analog decoders and analog modulators/upconverters in their networks with digital QAM modulators to complete the transition.

But, beyond its role in spurring the transition to all-digital, digital simulcasting also offers some notable benefits on its own. Many of these benefits are very similar to those of an all-digital network, including improved picture and sound quality for digital cable subscribers and parity with satellite television providers in pursuing and retaining digital subscribers.

Moreover, digital simulcasting generates significant capital cost savings for cable operators by eliminating redundant analog and digital equipment, such as separate analog and digital transmission, ad insertion and Emergency Alert System (EAS) gear. In a digital simulcast environment, operators can use the same ad insertion equipment, and, depending on the decoders used, the same digital EAS equipment for both analog and digital channels because all the services are carried throughout the network in digital form and the ads are inserted in digital format on all services. To use the same EAS systems, operators can take advantage of new equipment capable of supporting standards-based, digital EAS protocols defined in the SCTE 18 standard. Cable operators can also deliver non-intrusive EAS crawl overlay messages to analog cable subscribers when edge decoding or NTSC modulation devices support this capability, providing similar environments for digital and analog subscribers. In addition, operators can save costs on new cable set-top boxes because new digital service installations involve less costly digital-only set-tops.

On top of the capital cost savings spelled out above, there are operational cost savings to be realized from digital simulcasting. Cable operators can use the same set of video processing and distribution products throughout the network, dramatically improving service reliability and thus cutting customer service costs. Operators can also reduce costs by simplifying their network architecture because fewer video processing and delivery products are needed, and the newer transport and digital video processing products are usually simpler to operate and easier to manage and maintain.

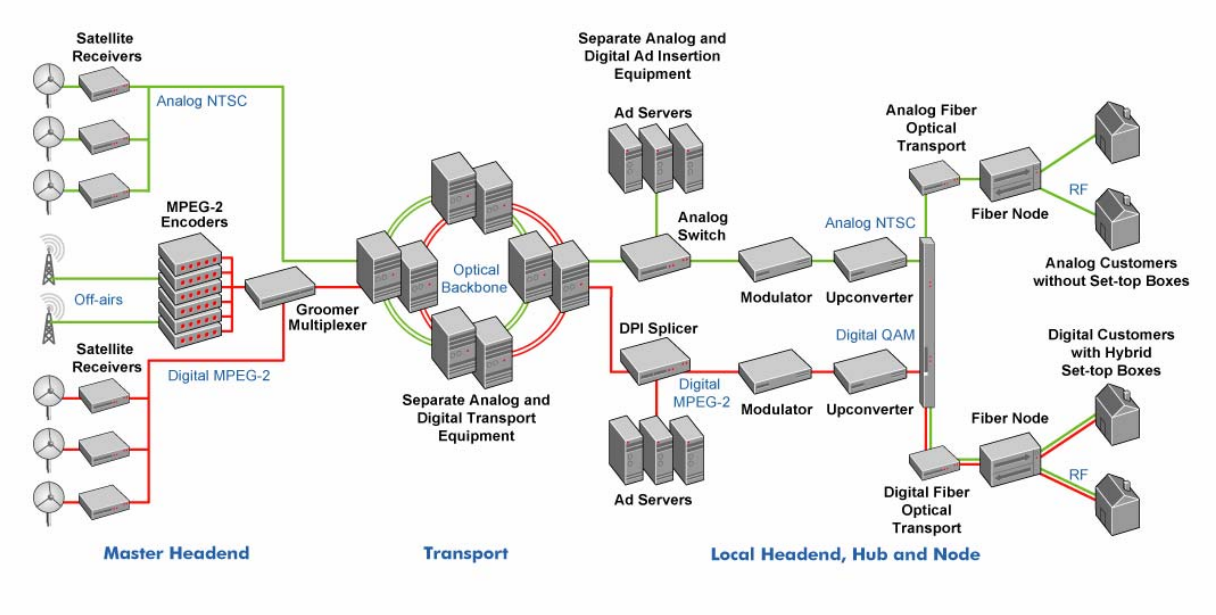

Figure 2: Separate analog and digital transports

When switching to the new simulcast architecture, cable operators can also install products that offer new features, including full manageability through standard network management protocols such as Simple Network Management Protocol (SNMP), for full network monitoring and remote configuration. These advanced products help to build a fully redundant, reliable network that can offer full redundancy for all components, from encoders at the cable headend to decoders and modulators at the hubs. To increase reliability, operators may also opt to build multiple traffic paths for network and service level redundancy at different points in the network.

Operators may also be able to take advantage of backbone and transport network bandwidth savings attained through digital simulcasting. Although additional bandwidth is necessary at the hub, since all video programming is converted to digital format at the headend, less bandwidth is needed to carry the programming from the headend to the hubs. So there is more bandwidth available for other uses in the network, such as distributing advanced, revenue-generating services.

Plus, digital simulcasting allows cable operators to deliver a more flexible mix of basic cable channels, as well as more advanced services, to subscribers. With all analog content also available digitally, operators can mix and match channels more freely in different packages, just as satellite operators do in the satellite television market. Cable operators can also offer VOD and other On Demand and interactive services to new basic subscribers equipped with the proper digital cable-ready television sets and/or set-top boxes.

An Alternative Architecture for Digital Simulcast

Although in most cases the digital simulcast architecture eliminates dual analog and digital content carriage throughout the network, some operators may choose a different path. In this alternative architecture, even though analog content is encoded as digital at the headend, the analog and digital content are both carried separately throughout the network and all the way to the hubs. The purpose for the encoding of analog content is so that the digital subscribers benefit from a full digital program line-up, and the operators can utilize digital-only set-top boxes in these homes. However the analog subscribers continue to receive the same analog channel line-up they receive today since the analog content is also distributed concurrently throughout the network. In this architecture, the need for decoding of the digital programs at the edge is eliminated and the analog subscribers are supported as they are in today's environment.

At first glance this architecture may sound simpler to deploy, however, it lacks some of the important advantages of the architecture discussed previously, and also poses some new issues. The dual transport of the content throughout the network means that the operators would have to retain all current analog transport, video switching and ad insertion products. And because analog content is converted to digital at the headend, they also need additional equipment to support these functions in digital for the same programs. This requirement increases operational overhead and also complicates the network architecture. Additionally, the dual carriage requires additional bandwidth in the transport network from the headends to the hubs. Finally, although some of the advantages of the previous architecture are also realized for digital program line-ups, such as better manageability and reliability, the analog line-up will still be delivered through traditional analog distribution products, which in some cases are out of warranty and lack the level of reliability and manageability of their digital counterparts.

Digital Simulcasting Costs

Of course, there's no such thing as a free lunch, even in the digital wonderland. In return for the benefits outlined above, digital simulcasting does present some challenges for cable operators. But these challenges can either be minimized or they pale in comparison to the potential benefits.

Initially, probably the biggest issue is the increased bandwidth requirement at the edge. Although digital simulcasting eventually leads to bandwidth savings at the edge by accelerating the switch to all-digital networks, it ironically requires more bandwidth in the short run because cable operators must use more spectrum to deliver analog and digital versions of each channel to subscribers' homes. Estimates are that operators need to dedicate an extra five to seven 6 MHz channels for the heavier load if they wish to maintain their existing analog line-ups. Figure 3 shows the bandwidth usage in today's environment and the additional bandwidth needed to carry the encoded content in a digital simulcast environment. Although these figures show the use of portions of the digital spectrum for digital simulcasted services, some operators opt to use analog spectrum freed through the elimination of certain analog channels instead, which helps to avoid the elimination or reduction of digital services.

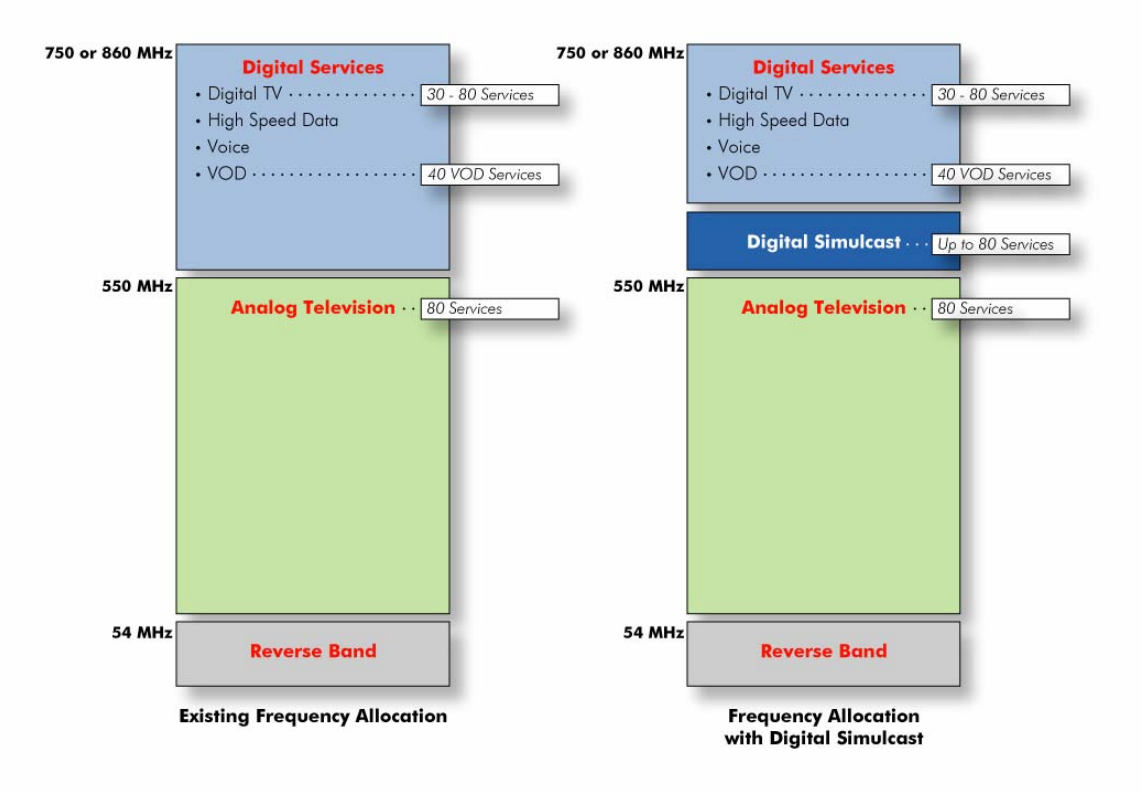

Figure 3: Cable frequency allocations

Adding additional expense, cable operators must convert all analog video services to digital format at the headend, requiring them to install new video encoding, grooming and multiplexing equipment to carry out the conversion. Digital simulcasting also requires new digital ad insertion equipment to replace existing analog ad insertion devices, however this equipment will continue to be used well into the digital future.

For those subscribers upgrading to digital service to take advantage of the new, all-digital offering, cable operators also face the additional cost of placing more digital set-top boxes in subscribers' homes. Although the new digital-only set-tops may cost less than the older hybrid analog/digital boxes and should lead to higher subscriber revenues, they still represent a sizable capital outlay in the short run. Cable operators must be prepared to meet that additional initial expense.

Nevertheless, the long-term gains of digital simulcasting are clearly well worth the short-term pain, particularly as simulcasting eases the transition by cable operators to all-digital networks. In contrast, further plant upgrades to gain additional bandwidth would be far more expensive and yet might not produce nearly as much benefit. For instance, a cable system with an 860 MHz plant that upgraded to 1 GHz but kept its analog distribution would expand its digital carriage capacity by less than half of its existing digital bandwidth. On the other hand, conversion of the full analog program line-up to digital would free up more than 1.6 times the existing available bandwidth for digital services.

RGB's Intelligent Digital Simulcast Solution

RGB Networks has introduced the Simulcast Edge Processor 48 (SEP48), the cable industry's first complete solution for digital simulcast edge decoding applications. Based on RGB's Video Intelligence Architecture™ (VIA™), the SEP48 is a one rack unit platform that is designed for high-density video decoding and NTSC modulation. It is the ideal solution for simplifying and accelerating cable's transition to all-digital networks.

Figure 4: RGB Simulcast Edge Processor 48 (SEP48)

Simply put, the SEP48 prepares the digital programs for direct delivery to analog subscribers in a digital simulcast application. More precisely, the SEP48 can receive and decode up to 48 MPEG-2 digital video streams over Internet Protocol (IP). It then modulates and upconverts the streams to deliver them as NTSC analog video channels to analog cable subscribers in a digital simulcast application. Taking advantage of RGB's flexible video processing platform, the SEP48 provides cable operators with many advantages in the deployment of a simulcast network.

Simplifying Digital Simulcast

The SEP48 offers significant operational cost savings over alternative multi-box solutions. By combining MPEG-2 decoding, NTSC modulation and upconversion in a single product, the SEP48 greatly simplifies the design and support of the digital simulcast system. The multi-function product also eliminates the need for multiple decoders, modulators and upconverters, as well as the mess of interconnect wiring between them all.

In addition, the SEP simplifies compliance with digital Emergency Alert System (EAS) requirements through its support of program switching through SCTE 18 protocol messaging. EAS switching is triggered through SCTE 18 messages delivered in-band or over IP protocol, rather than through cumbersome contact closures. The SEP can switch all or a subset of programs to a digital EAS MPEG program during an emergency alert. Future versions of the SEP will also offer non-intrusive EAS crawl overlay support for lower priority emergency events.

In tandem with the cost savings, the SEP48 promises reduced complexity. With its integrated approach, the open-protocol product greatly simplifies the configuration of multiple functions, including the decoding, baseband modulation and upconversion settings, by enabling full set-up and configuration through a simple, logical, SNMP-based graphical user interface. Plus, it makes frequency allocation easier by providing for multiple, continuous channels in each of its 12 RF output ports.

The SEP48 also features a fully programmable chassis, granting it great flexibility for support of future applications. While the product is initially configured to carry out the MPEG-2 decode and NTSC modulation functions, additional features can be supported through software upgrades as they become available.

The RGB SEP platform offers high reliability as well, thanks to its strong redundancy options. It supports 1:1 redundant configurations for both the MPEG-2 decode and NTSC modulation functions through the use of RGB's Redundancy Docking Station (RDS) which can hold two chassis configured as primary and backup devices. The RDS simplifies redundancy configuration and also avoids additional re-wiring in the event of a chassis failure. If a device fails, it can be easily removed and replaced with a new device without the need for RF cable rewiring. The redundancy architecture provides for both network and RF port redundancy support.

Finally, the SEP48 generates considerable savings in both power and rack space consumption. On the power front, the platform requires less than 500 Watts for support of up to 48 NTSC modulated and upconverted channels. This number compares quite favorably with designs based on separate decoders, modulators and upconverters, which can consume as much as 10 times the power. In addition, due to the higher power requirements, the multi-box, low-density solutions have much higher cooling and air-conditioning requirements.

As for space savings, the SEP48's single rack unit design can save as much as a full seven-foot rack per hub location for an 80-channel analog cable system, when compared with low-density, multi-box solutions.

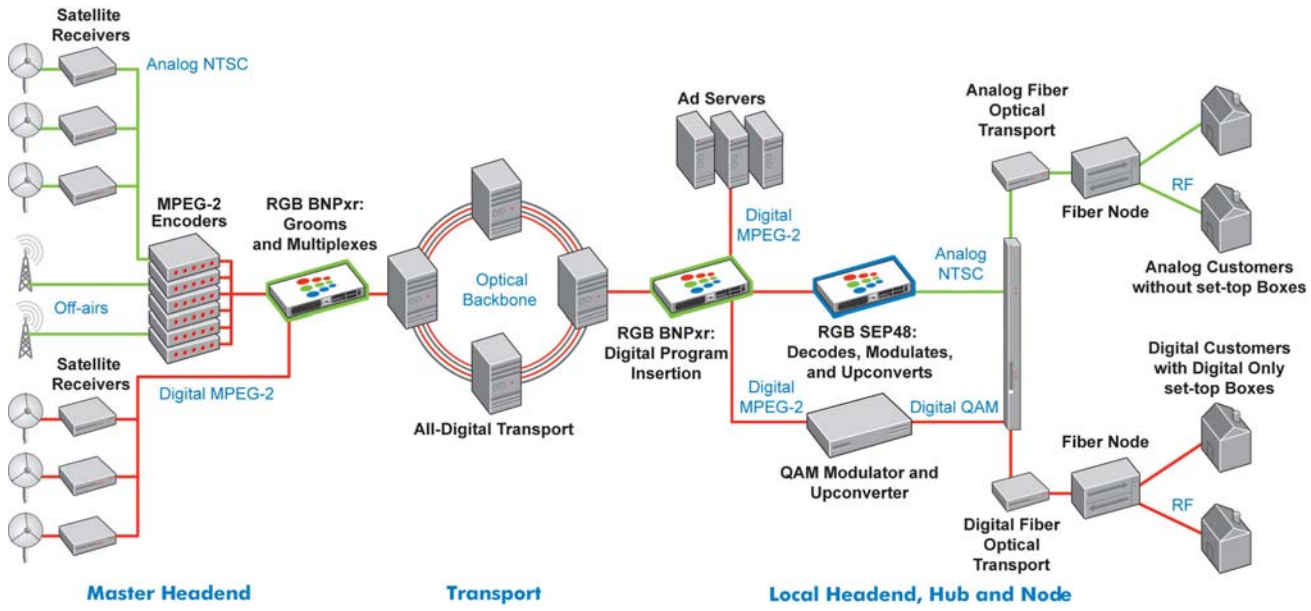

Figure 5: Simplified digital simulcast environment with RGB SEP48 & BNP*xr*

In combination with RGB's Broadcast Network Processor (BNP*xr*) for high density grooming, statistical multiplexing, transrating and digital program insertion (DPI), RGB provides a highly scalable, simplified, seamless video processing solution in the digital simulcast environment.

Features & Capabilities	RGB Simulcast Edge Processor	Multi-Box Solutions (decoder, modulator, upconverter)
High density MPEG 2 decoding	Up to 48 channels	Single channel or low density decoding
Integrated modulation and upconversion	Up to 48 channels	No modulation and upconversion
EAS support	Digital	Contact closure
Redundancy options	Chassis and all interfaces, including RF ports	None – requires complicated mess of wiring and external switches
Power consumption	Less than 500 W	More than 10x for similar configuration
Rack space	1 rack unit for 48 channels	Approximately 2/3 of a full rack for a similar configuration
Future upgradeability to support new features	Yes	No

Table 1: Benefits of RGB SEP48 compared to multi-box solutions

Conclusion

Cable operators have very good reasons to accelerate the transition to all-digital networks, including such highly desirable benefits as capital and operational cost savings through simplification of the network architecture, as well as the use of lower cost digital set-tops; bandwidth optimization, which allows the addition of advanced, revenue-generating services; and better picture and sound quality, providing marketing parity with satellite television providers. The bandwidth savings alone would be enormous, freeing up as much as 500 MHz of spectrum for other, more beneficial uses. More importantly, moving to all-digital enables cable operators to offer their subscribers a unique, truly On Demand viewing experience, enabling them to watch what they want, when they want through a fully switched digital network architecture.

Digital simulcasting represents a smooth, controlled and logical way to spur the switch to all-digital without causing potentially massive service or subscriber disruptions. Besides accelerating the all-digital transition, digital simulcasting offers numerous benefits. The list includes:

- Improved picture and sound quality for digital cable subscribers
- Greater parity with satellite television providers
- Significant capital and operational cost savings
- Bandwidth savings on the transport network
- The delivery of a more flexible mix of programming

Additionally, using the right architecture and products can simplify the process of installing and maintaining a digital simulcast deployment. The RGB Simulcast Edge Processor delivers the cable industry's first complete solution for digital simulcast edge decoding applications. With the high-density, fully manageable and reliable SEP product, operators can simplify cable system operations, save bandwidth and pave the way to a fully digital network, while still supporting their existing analog subscribers.

Although digital simulcasting presents its own challenges for cable operators, these challenges are short-term and can be minimized or overcome. In any event, the short-term pain pales in comparison to the long-term gain that digital simulcasting offers, especially as a major step along the road to the promised land of all-digital.

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