Marconi

DISC★S® Deep Fiber HFC™

A Next Generation Integrated Access Solution Offering Significant Improvement Over Traditional HFC Architectures

By Tom Spoor, Product Line Manager
Bill McElroy, Marketing Account Manager
Steve Kirkpatrick, Marketing Account Manager

Introduction

The communications landscape is undergoing a dramatic metamorphosis as the new century commences. Sparked by the lifestyle transformation to a data-centric age, customers now demand lightning-fast data rates, video-on-demand and advanced voice applications. The latest, the fastest, the best—now!

In response to these customer demands, service providers are seeking an alternative solution to the multiple drawbacks of traditional hybrid fiber coax (HFC) systems. This solution must allow service providers to reliably and effectively deliver integrated voice, video and broadband data services to customers at minimal installation and life cycle costs. And to offer these integrated services, a system is needed that utilizes existing customer premises equipment (CPE) and offers overall advantages in such areas as maintenance, power, scalability and network evolution. Service providers who can successfully address this challenge to meet customer demands will gain a competitive market advantage.

Marconi Communications' solution is designed to avoid the prevailing shortcomings of traditional HFC platforms. DISC★S® Deep Fiber HFC™ with radio frequency (RF) return over fiber in the loop (FITL) is Marconi's local access system solution that allows service providers to offer and provide the high-speed, integrated services their customers are demanding.

The Deep Fiber HFC architecture incorporates a patented upstream RF return capability into Marconi's proven DISC★S flexible access platform. The Deep Fiber HFC architecture uses Marconi's patented single-fiber, low-power star topology. Optical Network Units (ONUs), located within a few hundred feet of the customer's home or apartment, provide telephony services over twisted pair copper plus subcarrier modulation (SCM) broadcast video and high-speed Internet protocol (IP) data services over coaxial cable. Up to 24 homes can be connected to each ONU, and more than 2,000 customers can be serviced from a standard DISC★S configuration.

This paper will illustrate the inherent features and benefits that distinguish Deep Fiber HFC from traditional HFC systems. Furthermore, we will examine the Competitive Local Exchange Carrier (CLEC) market, in addition to Multiple Service Operators (MSOs), Overbuilders and Utilities.

Also how the DISC★S Deep Fiber HFC access solution facilitates cost-effective and future-safe delivery of voice, video and datacom services for each of these service providers will be examined.

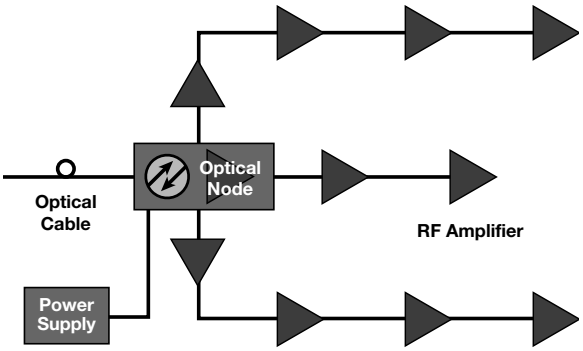

Figure 1. Traditional HFC Network

The Traditional HFC Network

A traditional HFC configuration (see Figure 1) contains multiple shortcomings, limiting the ability of service providers to install a reliable, future-safe network.

Cable television (CATV)-based architecture is extremely complex and becomes even more complicated when voice service is introduced. Trunk and bridge amplifiers, internal couplers, diplex filters and

automatic gain control (AGC) modules all represent potential network failures. Further potential failure is caused by conversion of the nodes from alternating current (AC) to direct current (DC), which often results in fusing problems.

The HFC system, typically designed to service 500 homes, can result in video signal degradation and intermodulation distortion. As voice traffic increases on the network, these problems can intensify as competition or contention for bandwidth grows.

The traditional HFC infrastructure is cost-intensive due to the multitude of Network Interface Units (NIUs) contained within the system. These power nodes are not hardened; therefore power consumption of the node and all active electronics is high. Because the RF section requires an expert craft interface to allow the "set-up" of the levels and frequency response, proper equipment closure is critical.

Powering

The cost of powering a traditional HFC network is approximately 25 cents per month, per home passed. The HFC system is a decentralized, 2- to 3-hour standby, low-voltage network. The CPE equipment is powered by 60- or 90-volt alternating current (VAC) over the drop network, requiring several nodes and amplifiers to get the job done. Up to 15 amperes (Amps) exist in the HFC system, jeopardizing craft safety.

Maintenance/Monitoring

Maintenance of the HFC network is burdensome and complex. It requires fault isolation to each card/component. In addition, a system sweep for forward and return is mandatory. The uninterruptible power supply (UPS) system requires constant maintenance to assure battery integrity and to prevent loss of service. Lightning and foreign voltage protection is complex and expensive. The HFC architecture also demands signal leakage testing in the distribution and in the drop network. Furthermore, monitoring of the system is only available between the Central Office (CO) and the NIU.

Costs

Day One capital costs for an HFC system are expensive, totaling approximately $87,700 per mile (120 homes per mile.) Parallel coax and copper distribution networks call for a substantial investment in two separate communications systems. Twice as much conduit is needed and each network requires separate pedestals to terminate service. Life cycle costs are likewise high and include powering, maintenance, monitoring and upgrades.

Scalability

The traditional HFC network requires extensive modifications to add service and network capabilities, most of which require additional bandwidth. With RF-based telephony, the return spectrum for data signals is limited by the need to transport telephony traffic. Due to these bandwidth limitations, data speed is decreased and there is a limited availability of high-speed connectivity. This usually translates into replacing the entire system to increase capabilities. In addition, telephony traffic transported in the return spectrum runs the risk of ingress contamination.

Availability

Because the HFC system is a CATV configuration modified to handle voice and data, the full-service network is calculated to deliver only 99.98 percent availability, or 1.76 hours less than Bellcore requirements for local telephony services (99.9996 percent minimum.)

Marconi's Next-Generation Access Solution: DISC★S Deep Fiber HFC

Marconi Communications' DISC★S Deep Fiber HFC (see Figure 2) is a local-loop access solution that offers competitive broadband and narrowband services, including high-speed Internet, interactive gaming, impulse pay-for-view, broadcast cable television and Plain Old Telephone Service (POTS). This solution fully supports legacy services, while providing a smooth path for network evolution and broadband service expansion. It single-handedly addresses the problems prevalent in the HFC network in the areas of powering, maintenance/monitoring, cost, scalability, evolution and availability.

Compared to the complex HFC configuration, the DISC★S fiber-in-the-loop platform consists of a simple, elegant Deep Fiber℠ architecture. Deploying optical technology close to the customer's home or apartment minimizes the type of ingress noise experienced by customers using traditional HFC shared-bandwidth systems. Installing fiber closer also improves network integrity and the capability for highest data throughput. The DISC★S-based network eliminates the need for devices such as amplifiers, and is network-powered rather than powered by distributed batteries. These techniques reduce potential failure points, simplify testing and lower maintenance costs.

The DISC★S Deep Fiber HFC with RF return system consists of a host digital terminal (HDT) and multiple distributed ONUs. The HDT is located either in the CO or in the neighborhood. Regardless, it is situated within 10,000 feet of the ONU.

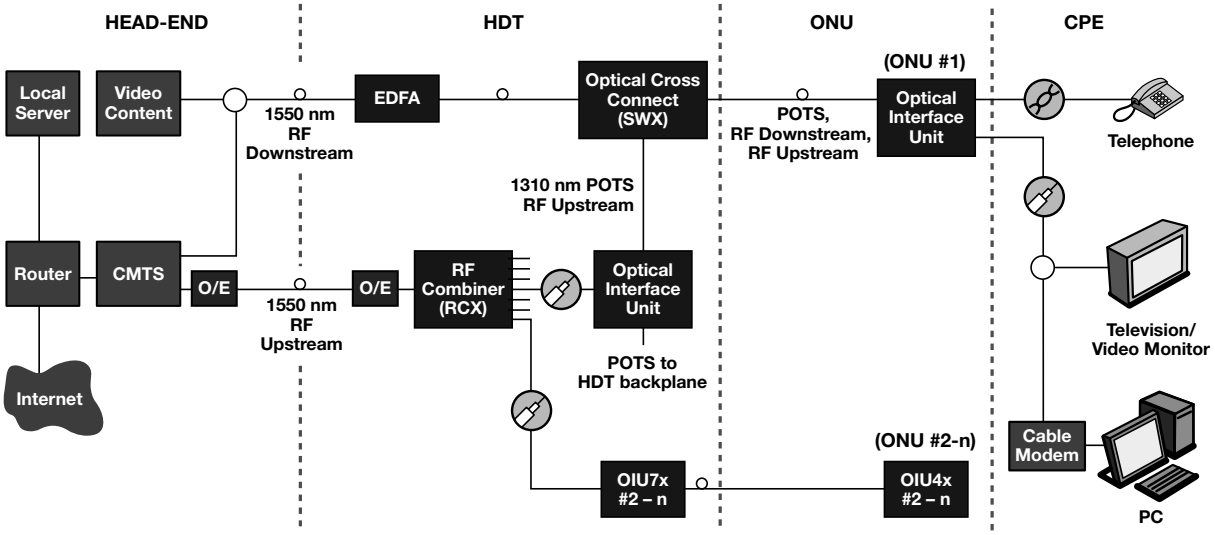

Figure 2. DISC★S Deep Fiber HFC

Downstream POTS and other voice services use a 1310 nanometer (nm) optical network to transport telephony traffic from the DISC★S HDT to the ONU, where the digital signal is down-converted and rendered as 24 analog voice lines.

Broadband RF (video and data) is typically placed onto the video transport layer at a Head-end or CO. Transport of broadband RF from the Head-end/CO to the HDT uses 1550 nm optical transmitters and erbium doped fiber amplifiers (EDFAs). Granular distribution of the broadband RF is accomplished at the HDT by using splitter optical cross connects (SWXs) to deliver the broadband RF signal in an optical format to each ONU. Typically, between 10 and 300 ONUs can be connected. From eight to 24 ports of RF can be provisioned at each ONU.

A single-fiber solution to the ONU for converged voice, video and data is obtained through wave division multiplexing (WDM). This is used to multiplex the 1310 nm POTS traffic with the 1550 nm broadband RF signals at the SWX within the HDT.

A WDM within the optical interface unit at the ONU separates the 1310 nm and 1550 nm optical signals. POTS signals are converted to baseband telephony signals and relegated to the 24 twisted pair punch-down locations at the ONU. Data Over Cable Service Interface Specifications (DOCSIS)-compliant signaling applications are achieved by splitting the broadband RF into SCM broadcast video and IP data. They are then transported via coax cable to the customer's set-top box or cable modem/computer, respectively.

Upstream transport of RF takes advantage of the unused spectrum within the 1310 nm optical transport. RF signals (9 to 42 MHz bandwidth) and POTS signals (0 to 3.088 MHz bandwidth) are multiplexed into a common 1310 nm signal for transport back to the HDT. Bulk transport of return bandwidth allows communication of all RF return signals, regardless of modulation technique or spectral allocation. Return path testing uses National Cable Television Association (NCTA)-recommended practices.

Powering

Compared to the HFC network, the cost of powering the Deep Fiber HFC network is cut in half. The Deep Fiber HFC costs approximately $12.5 cents per home passed per month under equal deployment. Fewer power nodes are required due to higher voltage {130 volts direct current (VDC) versus 60 or 90 VAC}. Marconi's ONUs require the lowest power in the industry, resulting in lower operating costs. The Deep Fiber system boasts higher reliability since each ONU has its own power feed from the HDT. The system is limited to 100 volt amps (VA) to ensure craft safety.

Maintenance/Monitoring

The entire Deep Fiber network is remotely monitored by a Supervisory System (SS) from the Head-end/CO to the customer's wall jack (including hand-set.) Monitoring includes voice, video and data. The SS delineates where the failure is, where the technician should go and what needs to be delivered and installed.

As opposed to traditional HFC, the Marconi solution does not require sweeping of the forward and return path. Signal leakage testing is required on the drop network only. Because of redundant powering via batteries that maintain a constant charge, the Deep Fiber system is lower in maintenance. Lightning and voltage protection is simple and inexpensive.

Costs

Compared to the expensive deployment of the HFC system, Marconi's Deep Fiber HFC Day One capital costs are only $78,060 per mile, (120 homes per mile.) Furthermore, Marconi's Deep Fiber approach reduces construction and material costs by using a single network.

The Deep Fiber platform reduces life-cycle operating costs in all areas including maintenance, power, monitoring and upgrades. Compared to HFC systems, the most expensive part of the network—the outside plant—does not have to be replaced to provide new features or generate additional revenue streams.

Scalability

Theoretically, fiber has no upper limit for bandwidth scalability. The Deep Fiber HFC network is a "future-proof" network designed to address customers' needs today and tomorrow. Fork-lift upgrades and ad hoc overlays are eliminated. Instead, cards and electronics are upgraded to deliver a clear and unobstructed migration path to future services. With Marconi's total access solution, 50 to 870 MHz bandwidth with full RF return is available by simply upgrading two cards—not replacing the entire plant.

Availability

Unlike traditional HFC, Deep Fiber HFC meets or exceeds the Bellcore requirements of 99.9996 percent for local telephony services.

Benefits of Deep Fiber HFC to CLECs, MSOs, Overbuilders, and Utilities

CLECs are one of the service providers that benefits most from Marconi Communications' Deep Fiber infrastructure. Competing on a selective basis for local exchange service as well as long distance, international access, CATV and video-on-demand, CLECs have a tough task. Amid intense competition, especially from Incumbent Local Exchange Carriers (ILECs), CLECs need trusted, turnkey solutions to help boost their market share.

Employing Marconi's DISC★S Deep Fiber HFC system arms the CLEC with the equipment needed to gain a competitive advantage. With bandwidth demand continuing to outstrip network capacity, a robust carrier-class system is needed. This system must allow the CLEC to deploy broadband and narrowband services while maintaining and improving revenue-generating legacy services.

For the bandwidth explosion of the Internet revolution, Marconi's flexible and scalable Deep Fiber HFC platform provides the CLEC with key technologies to meet the increasing needs of end users.

MSOs

With cable infrastructures installed in 90 percent of American neighborhoods, MSOs (video operators) are well positioned to become the single-source service provider for bundled voice, video and data services.

Deep Fiber HFC provides MSOs with the opportunity to develop new revenue sources by expanding their service offerings while leveraging CPE. Customers are choosing cable modems as a quality alternative to standard dial-up Internet connections. They favor a connection-less, always-on service that eliminates the dial-up process and the

installation of a second telephone line. Ingress issues, common to the bussed architecture of traditional HFC, are eliminated, thus significantly improving the quality of service and reducing customer complaints.

Partnering with Marconi offers MSOs a high-technology developer who thoroughly understands the business case and market opportunities associated with integrated service delivery. By using the Deep Fiber HFC platform, MSOs benefit from a state-of-the-art system that offers converging voice, video and data services via existing coaxial cables, set-top boxes and cable modems.

Deep Fiber HFC is the ideal future-safe solution in today's evolving communications environment.

Overbuilders

The Deep Fiber HFC integrated access solution offers many benefits to Overbuilders, who are embroiled in the battle to gain market share in voice, video and data services delivery.

As the Overbuilder attempts to gain a city franchise to create a new CATV system, the multiple benefits of the Deep Fiber HFC platform ensure a solid business case for delivering high-quality services, quickly. In addition, the Deep Fiber HFC system allows the Overbuilder to design—from the ground up—a future-proof system that integrates a full range of legacy and next generation technologies. Concerns about future multiple equipment purchases and system overhauls are eliminated.

Low Day-One capital outlay and relatively inexpensive construction and operating costs due to the "fiber to the last active"SM, are compelling advantages for the Overbuilder.

The single-fiber technology allowing fiber to be extended close to the home or apartment also provides an unprecedented advantage. When the benefits of a uniform, cost-effective maintenance and monitoring system are added to the mix, Marconi's Deep Fiber HFC should be the Overbuilder's system of choice.

Utilities

Retail competition has radically altered the business model for Utilities. In light of these market changes and business opportunities, power utilities are analyzing how best to compete.

Many publicly-owned Utilities as well as Investor-Owned Utilities (IOUs) are applying for certification by their state Public Utility Commission (PUC) or Public Service Commission (PSC) to become a CLEC.

The Utilities' built-in advantages include generous rights of way, embedded infrastructures, high market penetration and extensive customer databases. Driven by consumer demand for high-speed Internet access and emerging voice and video applications, utilities are expanding the services they offer. Fortunately, these advanced communications services can be readily deployed from an existing utility infrastructure.

Customers are prepared to buy a full array of services from a single vendor. Given its wealth of industry experience, Marconi is a natural partner for the Utility turned CLEC. The Deep Fiber HFC system is a simple access solution providing the Utility with state-of-the-art, advanced bundling capabilities. From high-speed data to video-

on-demand to lifeline POTS, the Deep Fiber architecture furnishes the utility with a myriad of applications needed to compete in the cyberspace era.

Most importantly, Marconi is able to provide the utility entering this market with "total solution" turnkey services, from engineering the network to installing fiber, curbside cabinets and ONUs.

Conclusion

Communications service providers are compelled to employ innovative measures to improve bandwidth utilization. Marconi's DISC★S Deep Fiber HFC platform is a hybrid system able to handle voice, video and data with equal dexterity.

By mitigating the congestion and ingress problems of a traditional HFC system, Deep Fiber HFC allows users to enjoy an attractive menu of services that provide seamless end-to-end connectivity. In addition, service providers will recognize significant cost savings in the reduction of initial cash outlay and upgrades performed on an incremental pay-as-you-grow basis.

Deep Fiber HFC is the ideal future-safe solution for the CLEC, MSO, Overbuilder and Utility in today's evolving communications environment. The flexible, scalable system provides the tools to address high-demand, high-reward services quickly and efficiently, minimizing capital investment and maximizing returns.

Marconi

Marconi Communications
8616 Freeport Parkway
Irving, TX 75063

Telephone: (800) 837-4488

www.marconi.com

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