



Cable and Satellite Digital Entertainment Networks

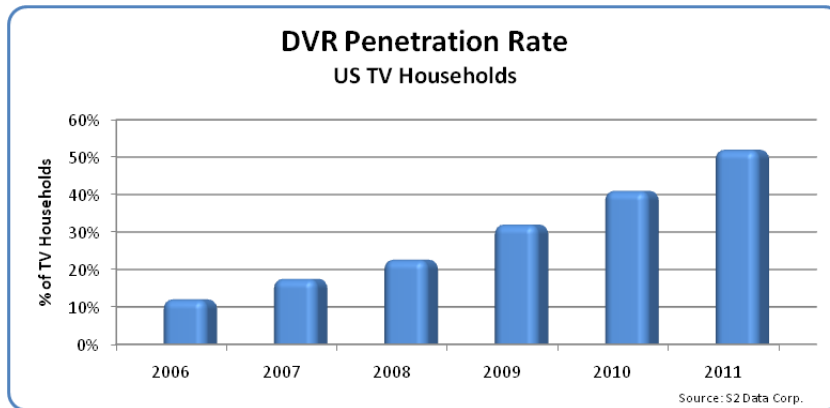
Moving towards an Integrated Digital Media Experience

INTRODUCTION

Traditional broadcast TV viewing models are eroding as consumers embrace new content consumption technologies. Driven by DVRs, high-definition (HD) content, and the emergence of multiple HDTVs per household, cable MSOs and satellite operators are moving to deploy robust digital entertainment networks to enable distribution of content within the home.

DIGITAL VIDEO RECORDING

Digital Video Recorders have created a paradigm shift in consumer television viewing habits by allowing viewers to control what, when and how they watch television content. A DVR is a digital set-top box with a hard disk drive

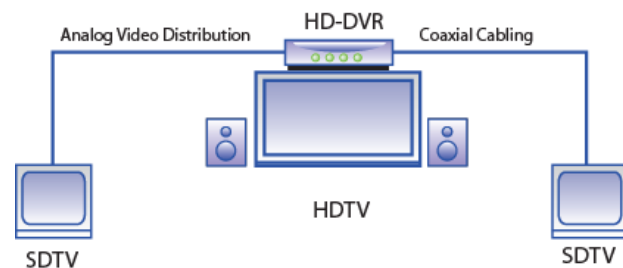


which enables viewers to record, store and ultimately personalize their viewing experience. Going beyond basic time-shifting of broadcast television, DVRs allow consumers to playback content using 'trick-mode' functions such as fast-forward, pause and fast-reverse. The popularity of DVRs is undisputed and they have become an integral part of cable and satellite TV offerings. Operators

report a significant reduction in customer churn, increased ARPU (average revenue per user) through rental fees, and increased customer satisfaction when DVRs are deployed in the home. The table to the left illustrates the rapid and sustained growth of this market.

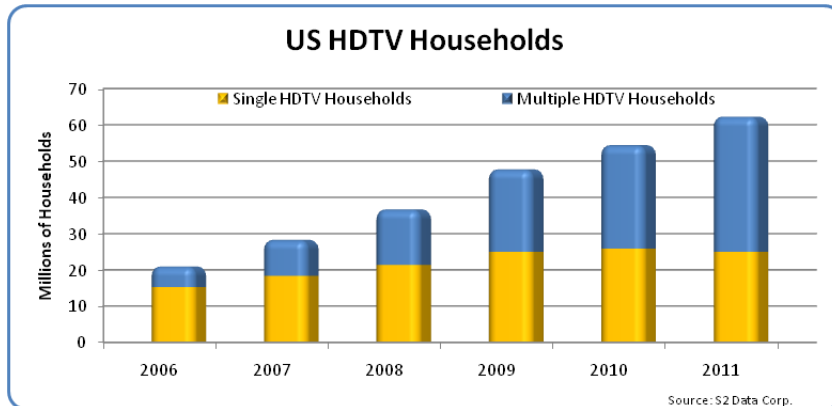
The popularity of time-shifting is rapidly evolving into consumer demand for multi-room or whole-home DVR solutions enabling recorded content to be served from a common hard-drive based DVR and watched in any room in the house. The absence of an entertainment network currently requires operators to employ analog distribution to enable whole-home DVR functionality.

Analog video distribution can provide a relatively simple solution to whole-home DVR and allows content to be accessed by other TVs in the home without requiring a separate STB to decode a digital video signal. However, this solution severely limits quality and functionality and may require separate coax runs and switches making it an unattractive solution. Distributing recorded high-definition content to secondary TVs within the home requires the content to be down-converted to standard-definition and distributed over the existing coax wiring to other locations within the home.



Although analog video distribution is a viable alternative, the availability and prevalence of high definition content and HDTVs is causing a dramatic shift in multi-room DVR requirements and increasing demand for operator-deployed entertainment networks.

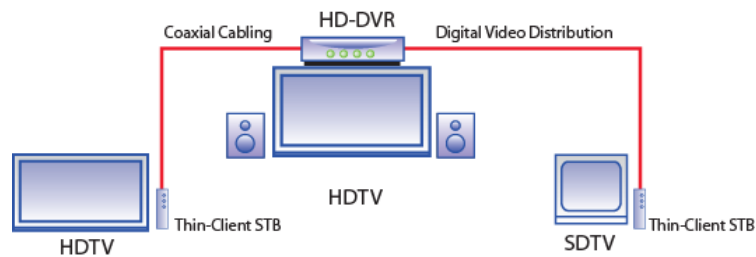
The primary driver behind operator-installed entertainment networks is the transition from single HDTV households to multiple HDTVs per home. S2 Data Corporation's research confirms that consumers who currently



own a single HDTV are more likely to purchase and replace secondary TVs with High-Definition TVs. The number of US HDTV households is expected to grow from 20 million in 2006 to more than 60 million in 2011. By 2010, S2 Data forecasts the number of multiple HDTV households will exceed single HDTV household, with the trend becoming more pronounced in 2011 and beyond.

While many current whole-home DVR service models assume a single HDTV connected to an HD-DVR with stored content distributed to secondary TVs using an analog signal, this model is only viable in the short-term.

Distributing multiple streams of HD content from a central DVR will require a robust entertainment networking technology capable of high data rates and low bit error. This implementation also requires the use of cost-effective 'thin-client' STBs located throughout the home to receive and decode the HD stream.



The following section will discuss key technical parameters cable MSOs and satellite operators will use to evaluate home networking technologies capable of meeting their unique requirements.

ENTERTAINMENT NETWORK TECHNOLOGY REQUIREMENTS

Cable and satellite operators share a common set of parameters used to evaluate home networking technologies that will allow them to deliver and distribute video content reliably throughout the home.

- No new wires
- Coexistence with broadband access and content spectrum usage
- Quality of service / Guaranteed Bandwidth

NO NEW WIRES

Despite distinct differences in service offerings, infrastructure and spectrum usage, the prevalence of existing coaxial infrastructure in nearly all North American homes has made it the de facto standard which cable and satellite operators use to distribute video, voice and data services throughout the home.

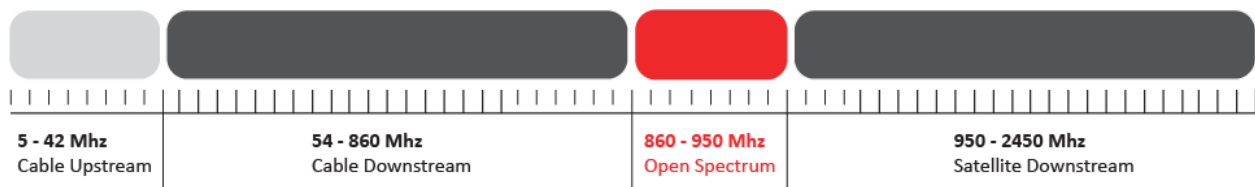
Operators universally agree that economical deployment of entertainment networks requires installers to reuse existing in-home wiring infrastructure in order to dramatically reducing network deployment costs. Existing in-home wiring solutions may include powerline, phone line and coaxial cabling.

Implementing entertainment networking over existing coaxial cabling provides cable and satellite operators with distinct benefits unmatched by other alternatives. Unlike copper twisted pair wiring, coaxial outlets are generally located in close proximity to TVs already receiving entertainment services from operators. While powerline provides numerous potential outlets, conditions can degrade rapidly if appliances and other devices are operating on the same circuit, making it ill-suited for transmission of HD video which requires guaranteed QoS. As a shielded medium, coaxial cabling is not subject to interference from external RF emissions, and is easily isolated from neighbors through the use of inexpensive filters.

Despite the many advantages of coaxial cabling as a home networking medium, transmitting packets at high speed over coax does present some unique challenges. Transmitting signals over coax can generate echoes and attenuation which if exceeded will degrade signals and cause packet loss. Although many home networking technologies purport to run over coaxial cabling, the Multimedia over Coax Alliance (MoCA™) standard was developed specifically to overcome these challenges and has undergone extensive field testing under a variety of conditions to ensure operators can deploy services to any coaxial outlet within the home.

COEXISTENCE WITH BROADBAND ACCESS TECHNOLOGIES AND CONTENT SPECTRUM

Although cable MSOs and satellite operators both carry services over coaxial cabling, each operates in unique segments of RF spectrum. The following diagram denotes the downstream and upstream RF frequencies occupied by operators.



Home networking technologies operating above 860 MHz are ideally suited to coexist with cable service offerings as they occupy space above both the downstream frequencies used to carry video content and baseband frequencies which carry upstream data traffic from DOCSIS cable modems.

Although satellite operators may provide Internet broadband data connectivity through third party operators in the 18-40 Ghz Ka-Band, it is particularly important that any home networking technology deployed must coexist with DOCSIS cable modems (Data Over Cable Service interface Specification) while not interfering with the Satellite L-Band spectrum used for video services.

Using an RF chip for conversion above 860 MHz, MoCA's networking technology operates in the open band of spectrum between 860 – 950 MHz, allowing it to coexist with cable and satellite as well as DOCSIS and xDSL modems operating in baseband frequencies.

Other networking technologies and mediums such as phone line and powerline do not interfere with downstream frequencies as they operate in the baseband frequency range, but may interfere with upstream frequencies used by cable modems in the 5 – 42 MHz range making them unsuitable for cable deployments. Although other

networking technologies operate well below L-Band frequencies, satellite operators may choose to deploy networking technologies such as MoCA which coexist with both cable modems and xDSL modems. This enables operators to offer consumers their choice of broadband provider without constraining choices due to potential spectrum conflicts.

BANDWIDTH AND QUALITY OF SERVICE REQUIREMENTS

Cable and satellite operators have targeted a minimum guaranteed throughput rate of 100Mbps for digital entertainment networks. This is not an arbitrary figure, rather it is based upon peak data rates per stream carried over the network. The following table represents a typical household with a single SDTV and two HDTVs. The first column represents peak bandwidths for each stream. Although most carriers employ VBR (variable bit rate) encoding, operators must plan for peak throughput in order to guarantee service.

Data / Video	3 TV Household	Trick Mode
HDTV (Primary)	19	40
SDTV (Secondary)	6	12
HDTV (Secondary)	19	40
VoIP	1	1
Gaming	2	2
Audio Streaming	1	1
Data	6	6
Total Bandwidth	54	102

Data rates for viewing programs stored on a DVR are identical to live TV programs. Configurations supporting simultaneous streaming of 2 HDTV and 1 SDTV streams along with data and voice services can be supported by home networks with bandwidth consumption in the 60 Mbps range. While data rates for viewing programs from a DVR are

consistent with live TV, the notable exception is “trick-mode” playback. Operations such as fast-forward and fast-rewind can increase bandwidth demands by a factor of 2 – 4x, depending on minimum picture quality standards and frame rates.

100 Mbps net data rate provides enough headroom to enable multiple HD and SD streams at peak data rates to coexist on the same network along with voice and data traffic. In addition, guaranteed 100 Mbps of net data rate enables multiple HD and SD streams of “trick-mode” viewing from a central DVR under all but the most extreme circumstances. Broadband data rates are also increasing due to competitive pressures, consumer demand and the introduction of new technologies. A baseline of 6 Mbps has been used in the table above; however some service providers are already offering data rates between 10 – 30 Mbps with speeds set to increase dramatically with the introduction of the DOCSIS 3.0 specification.

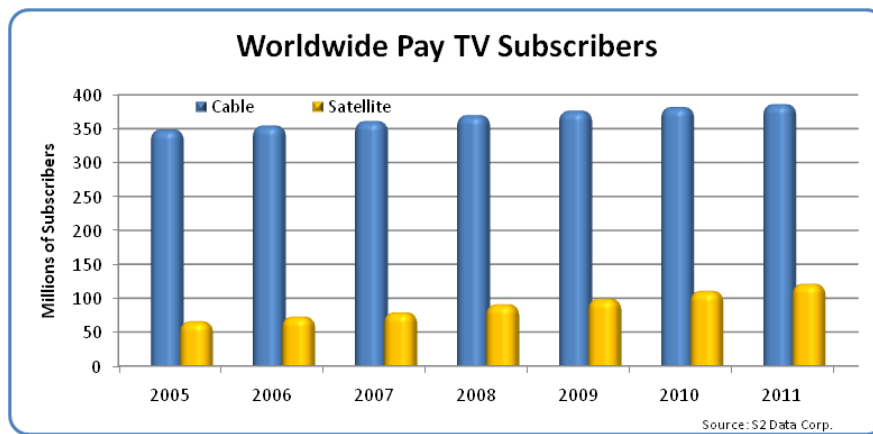
Field testing conducted with operators demonstrated that more than 97 percent of coax outlets achieved more than 100 Mbps net throughputs using MoCA entertainment networking technology, a figure well within operator constraints. While other networking technologies quote impressive PHY rates, guaranteed MAC rates are the one of the most important metrics which operators consider when evaluating network performance.

The mix of services offered by each provider will place unique demands and impact bandwidth requirements of the home network. Although sufficient bandwidth is essential to successful deployments, ensuring quality of service is of paramount concern when delivering video over the home network. Bit error rate (BER) and packet error rate (PER) has a dramatic impact on the perceived quality of the video service. Network latency and jitter can also have a negative impact on the quality of service and can lead to picture freezing, tiling, pixilation and garbled audio. MoCA has been designed to have low latency and jitter in order to support these multimedia requirements.

Home networks have typically been designed to support best effort data transmission, with dropped or lost packets being retransmitted in the event of network interruptions. However, real-time services such as video or VoIP cannot rely on lost packets being retransmitted. A single stream of video may be guaranteed throughput using priority-based QoS schemes. However, guaranteeing delivery of multiple streams requires parameterized QoS schemes and time-slot coordination to prevent collisions on the network. The MoCA entertainment networking standard specifies scheduled network communications to prevent network collisions and enable priority service flows. MoCA occupies a single 50 MHz channel with up to 8 nodes supported per channel ensuring that each stream receives guaranteed bandwidth.

A SIGNIFICANT MARKET OPPORTUNITY

Cable subscribers currently represent the single largest group of pay-TV consumers with digital satellite subscribers ranking a close second. As illustrated by the chart below, S2 Data expects cable subscribers to exceed 386 million subscribers by 2011 with DBS subscribers exceeding 121 million during the forecast period. By 2011, more than



500 million households worldwide will have cable or satellite pay TV subscriptions, representing nearly 50 percent of total worldwide television households. The forecasted growth of cable and satellite subscribers, multiple HDTV households and DVR deployments is creating a powerful impetus for operator-installed home entertainment networks.

Trials and early deployments will begin to accelerate over the next 12-18 months as operators deploy next generation set top boxes with integrated coaxial-based home networking technology.

ENABLING FUTURE SERVICES AND BUSINESS MODELS

The importance of operator-installed coaxial entertainment networks will increase considerably over the forecast period as operators develop additional revenue-generating services beyond whole-home DVR. In addition to delivering premium entertainment services to multiple locations within the home, operators are working to enable a fully integrated digital media experience allowing next generation set-top-boxes to act as media hubs allowing subscribers to access digital photos, music and videos normally stored on a home PC or other CE device. Because home computers are generally located in a home office or den, consuming digital content is generally limited to a fixed location. By allowing consumers to connect devices to the entertainment network, subscribers can enjoy their entire library of content in any room in the household where cable and satellite STBs reside.

Integrated digital media experience built on the backbone of entertainment networks allows operators to extend beyond simple content access and sharing, to developing new business models such as online music stores, Internet VOD partnerships, and online photo stores. Connected STBs can allow consumers to add to their digital music library through an online music store through the convenience of a remote control and in the comfort of the living room.

As consumer viewing habits evolve, subscribers are increasingly consuming more on-demand content. Connected CPEs (customer premises equipment) allow operators to pursue multiple VOD business models including Push VOD or Internet VOD. VOD content can be downloaded or streamed to the primary STB from a number of sources and viewed at any location in the home. This flexibility allows operators to pursue partnerships with a variety of content providers and enables compelling advertising models and other monetization strategies. In addition, consumers enjoy an enhanced customer satisfaction and improved TV viewing experience.

A PROVEN SOLUTION

MoCA enables cable MSOs and satellite operators to leverage a field-tested technology and existing coaxial infrastructure to meet the rapidly growing demand for distribution of digital multimedia around the home. As the standard for entertainment networks over coax, the end consumer is guaranteed interoperability with all other certified MoCA-based devices, no new wires or truck rolls, and seamless integration with already existing services and technologies in use. It is a win - win for service providers and consumers.