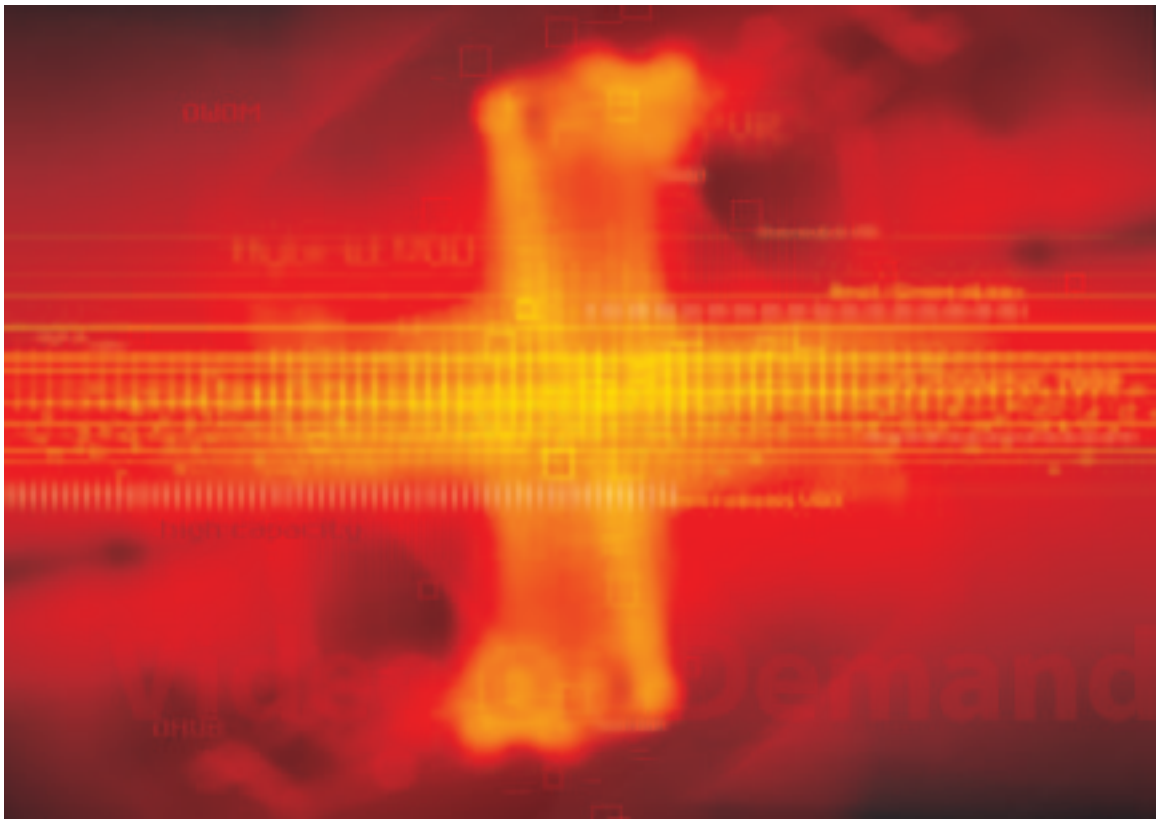
THE POSSIBILITIES ARE INFINITE FUJITSU

Fujitsu Powered Video on Demand Solutions



VOD Overview

Cable and telco triple play networks are quickly evolving to support hundreds of digital video channels, CD-quality music channels, cable modem/DSL data services, voice services and VOD services. The residential broadband services market is highly competitive with MSOs, direct satellite broadcasters, and telcos striving to attract and retain their residential customers. VOD represents a key service offering that differentiates MSOs and telco triple-play offerings from their direct satellite competitors, reducing churn and improving overall business margins. Fujitsu solutions for VOD transport networks ensure service providers can easily and cost effectively launch new VOD services.

VOD systems allow customers to select from a wide library of digitally stored movies and shows, allowing them to control and watch entertainment on their own schedule. No more trips to a video store on a rainy evening or scheduling your life around a fixed programming schedule. VOD provides entertainment flexibility.

Movies and entertainment shows, referred to as programming content, are stored in digitally compressed form on a number of VOD disk drives, similar to the hard disk drives found in home computers. VOD servers, running special software, control the flow of programming content from the hard disk drives to a residential set top box. A home user simply selects a movie or show from a menu of choices displayed on the set top box and within a few seconds, that entertainment choice (programming content) begins streaming into the set top box (see Figure 1). In addition to letting users watch what they want, when they want it, most VOD services provide VCR like controls to stop, pause, fast reverse and fast forward the movie.

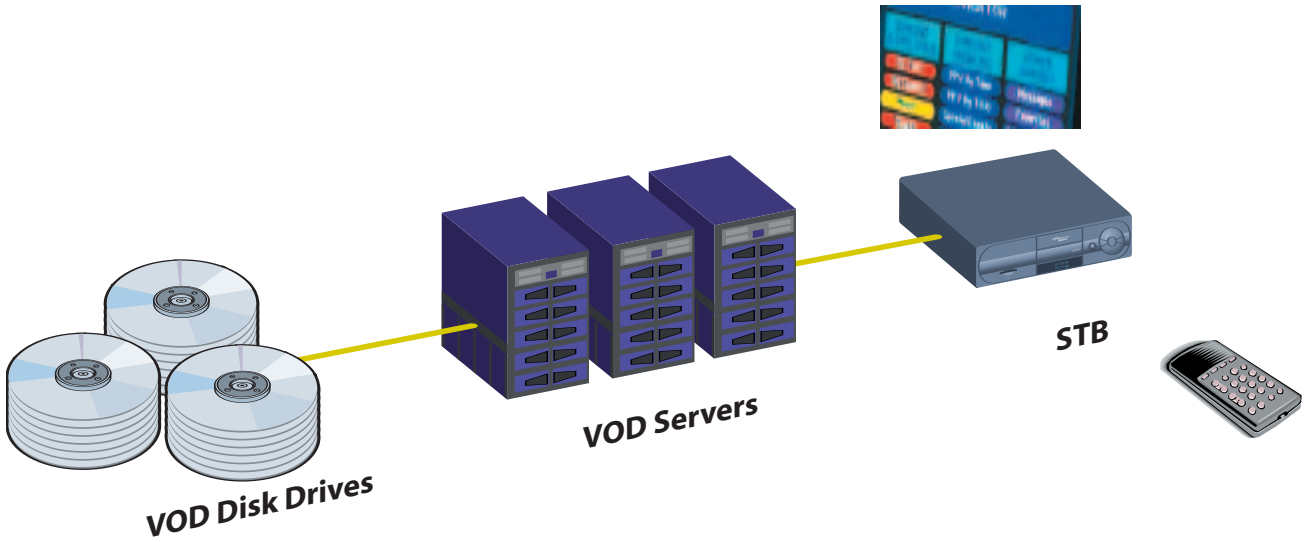


Figure 1: VOD Overview

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For your convenience, a list of acronyms can be found at the end of this document.

VOD Applications

While normally associated with Movies on Demand, a VOD infrastructure actually allows a number of different service types to be offered, including:

- Movies on Demand (MOD)
  This primary VOD service allows a residential customer to order any movie from a large library of digitally stored movies. The service is similar to picking a movie from a virtual video store, without the hassle of driving to a real video store, renting the movie and then returning the VHS tape or DVD the next day.

- Subscription Video on Demand (SVOD)
  SVOD is a subscription version of video on demand that allows customers to watch all of the programming content for a premium channel on their own time schedule. For example, the entire programming content for HBO for the last 30 days could be stored on the VOD disk drives. For a small additional monthly fee, HBO customers can opt for an enhanced service (HBO SVOD). This enhancement allows them to use the VOD network to view any of the HBO programming for that month at their convenience. This service enables entertainment on your own terms and on your own schedule.

- Networked Personal Video Recorder (PVR)
  PVRs are becoming an increasingly popular method to record TV shows and allow time-shifted viewing. A PVR incorporates a hard disk drive into the set top box in order to record digitally compressed programs for later viewing. Several high-end cable set top boxes are available with PVR functionality built into the units. The high cost of these advanced STBs remains an issue for many service providers.

As an alternative approach, MSOs and telcos can provide networked PVR services that don't require hard disk drives in every set top box. With a VOD system in place to support MOD and SVOD, simply adding additional disk storage to the existing VOD system allows extra broadcast programming content to be stored. Users can watch their favorite show when they want, similar to locally recording the program on a VCR or PVR.

VOD Architectures – Centralized

The Centralized VOD architecture deploys a single, large VOD system at a video headend with VOD streams transported across the network to multiple distribution hubs. Because a single VOD system is deployed, this approach tends to lower VOD hardware and software costs. In addition, receiving the programming content (asset reception), managing the VOD programming content (asset management), and overall VOD operating expenses are lower with a single, centralized VOD architecture.

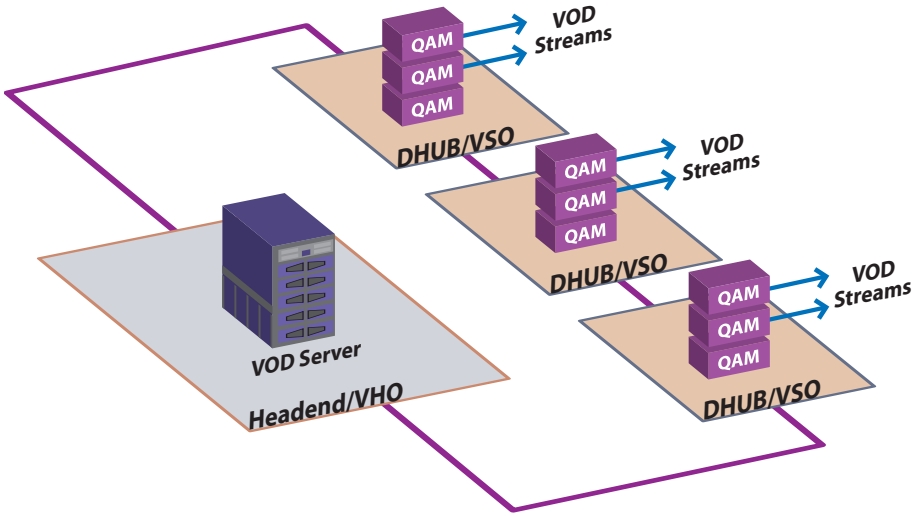

Figure 2: Centralized VOD

One of the challenges with a centralized VOD approach has been accommodating the bandwidth requirements associated with sending out the VOD streams from a single location. A large metropolitan area can require 20,000 to 40,000 VOD streams during peak usage periods, which is the equivalent of approximately 165 Gigabit Ethernet channels. Fortunately, Fujitsu ROADM solutions have dramatically lowered the cost of these core transport networks, making both Fujitsu ROADM and the centralized VOD architecture the preferred method for modern VOD networks.

VOD Bandwidth Planning

Figure 3 illustrates the bandwidth requirements to support commercial VOD services in a large metro market. In this example, the metro market is roughly the size of Dallas or Atlanta with 3 million people and 1.25 million households (homes, apartments, etc).

Size of Metro Market	3,000,000
Number of Households	1,250,000
• Number of Video Subscribers (40%)	500,000
• Number of Digital/Premium Subscribers (40%)	200,000
Peak Usage Time	Friday/Saturday, 7 p.m. to 10 p.m.
• Percent of Homes Ordering VOD at Peak Usage	20%
• Number of VOD Streams at Peak Usage	40,000
Number of VOD Streams per GigE (MPEG-2 @ 3.8 Mbps)	240
Number of GigEs Required for VOD Service	**167**

Figure 3: Market Assumptions

Assuming 40% of the available households (1.25 million) subscribe to a video package, the metro VOD market will have 500,000 subscribers or "subs." A 40% subscription rate is not an unreasonable estimation, especially when compared to current cable subscription rates of 50% 65% for most metro areas.

Typically, many households only choose a "basic" video package, consisting of 30–40 analog video channels. Since the low priced basic video packages only provide "analog" channels, STB is required to receive the "basic" service. However, without an STB, these customers cannot get advanced digital video services such as VOD. VOD services would only be available in homes choosing a Premium/Digital video package, or approximately 40% of the total video subscriber base. In our example, the number of homes with Premium/Digital video service, which also enables VOD, is 200,000 subscribers.

VOD systems are designed to support the peak usage times in order to prevent a "denial of service" to customers ordering VOD movies. Peak usage times are typically on Friday or Saturday evening from 7 p.m.–10 p.m. when family, teenagers, and friends gather to watch television. Assuming 20% of the Digital/Premium homes order a movie during this peak usage period, approximately 40,000 VOD streams would need to be supported simultaneously.

VOD deployments utilize GigE transport to connect the VOD servers at the master headend to each distribution hub (DHUB or VSO). The video industry norm is to allocate 240 VOD streams per GigE, assuming average video rates of 3.8 Mbps (MPEG-2). The 40,000 VOD streams generated during the peak usage period require a total of 167 Gigabit Ethernet signals, which is equivalent to 16–20 DWDM wavelengths.

To gain some perspective on how VOD bandwidth compares to other services, compare the 167 GigEs required for VOD service in our example, to the single GigE used to distribute the entire digital video broadcast package. A digital video package consisting of 125 digital channels, 10 HD channels, 40 pay per movie channels, and 80 CD-quality music channels easily fits into a single GigE. VOD is by far the most bandwidth intensive service in a modern broadband network.

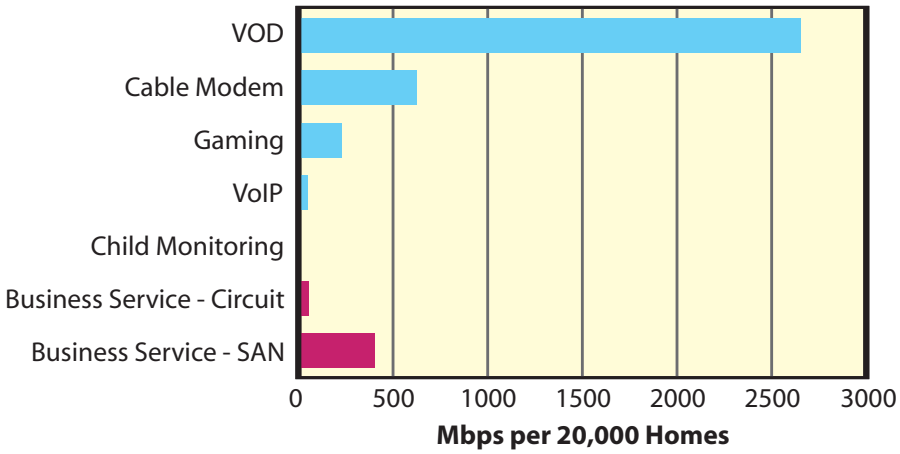

Figure 4: Bandwidth Requirements for MSO Services

Fujitsu ROADM—Getting to the Core of VOD

Providing VOD as part of a video services package reduces customer churn and provides additional revenue and profits. As shown from the example, VOD imposes significant bandwidth requirements on transport networks, which highlights the need for efficient, scalable GigE transport solutions. A ROADM network with high capacity GigE interfaces is the only cost effective solution to transport VOD streams and enable a profitable VOD service.

A modern VOD implementation consists of centralized VOD servers, typically provided by companies like SeaChange, Concurrent, or nCUBE®. VOD GigE output streams feed Layer 2 Ethernet switches that perform switching and aggregation of the video streams. Hundreds of these GigE channels are transported over FLASHWAVE® 7500 ROADM networks to distribution hubs (DHUBs/VSO). At the DHUBs, VOD streams can be connected directly to QAMs for transmission over normal HFC networks. For telco triple play applications, the VOD streams can be sent directly to IP DSLAMs, or alternatively connected through a local Services Edge Router or local Ethernet Switch.

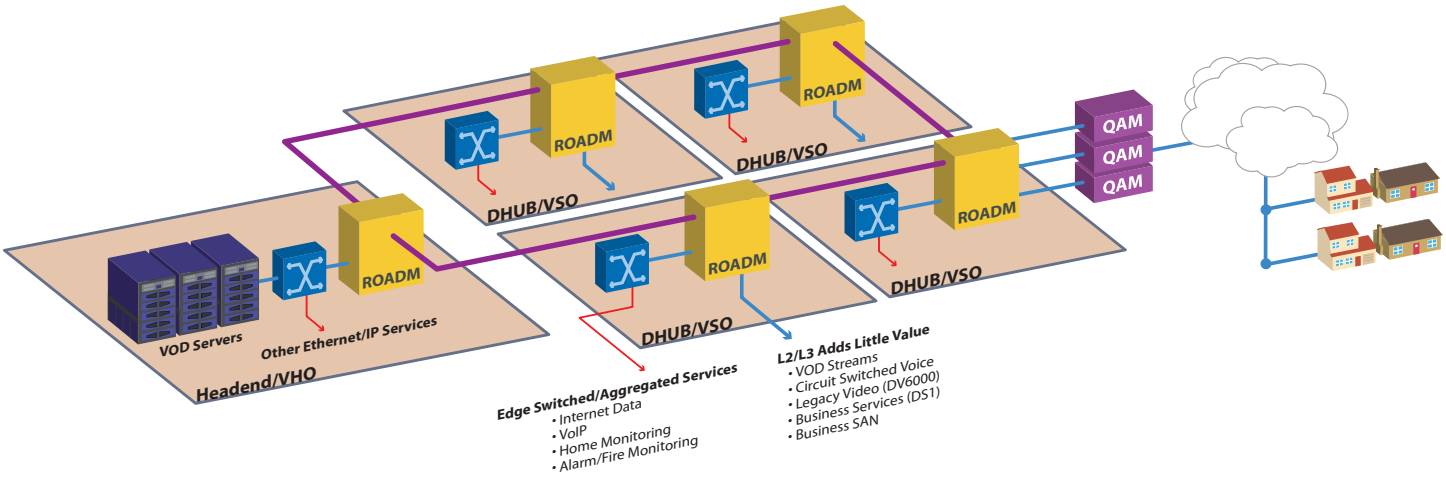

Figure 5: Modern Video/VOD Network

Fujitsu MSO VOD Deployments

Fujitsu has been a leader in the MSO industry in providing cost effective ROADM solutions, specifically for VOD applications. With over 265 metro DWDM nodes deployed at leading MSOs, Fujitsu holds a commanding +80% market share (RHK – Mar'05) for ROADMs in North America.

Figure 6: Fujitsu MSO VOD Deployments

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Cost Comparisons with L2/L3 Implementation

For telco triple play applications, several service providers are reviewing L2/L3 network architectures as an alternative to Layer 1 ROADM networks for VOD distribution. MSOs went through similar reviews and analysis two to three years ago, with the results showing significant cost savings when deploying a ROADM network.

The two primary issues in sending VOD traffic over L2/L3 data networks are costs and bandwidth. As shown earlier, a commercial VOD deployment in a large metro market can require as many as 167 GigEs worth of bandwidth during peak usage times. Ethernet switches or IP routers can certainly be sized to accommodate this amount of traffic, but the data networking approach can be very costly. In addition, real time VOD traffic is susceptible to additional latency and jitter introduced on multi-hop router/switch networks.

Actual MSO industry studies, comparing a L2/L3 architecture with a ROADM based alternative, highlight the cost advantages of using ROADMs for VOD networks. In the example shown in Figure 6, dual L2/L3 switch routers are deployed at every node. This dual ladder data architecture is a common technique to ensure network reliability when using data equipment, or IOS operating systems, that do not meet carrier grade performance and reliability standards. Direct optical interfaces on the L2/L3 switch routers connect to passive DWDM couplers and modular optical amplifiers providing optical connection to each site. Large inefficiencies result from the fact that traffic intended for any downstream hub must first pass through each and every intermediate hub. Pass-through traffic at these intermediate sites wastes costly optical interfaces and switch / router resources. Our simple example only shows four hub locations connected to the headend, but in real networks there are usually 8–16 Hubs/VSOs per Headend. As more Hub/VSO sites are added to the network, the inefficiencies and cost for this type of architecture worsens because the traffic passes through additional intermediate hops.

In addition to the cost issues, crossing multiple hops of L2 Ethernet switches or L3 routers can introduce significant latency and jitter into the VOD traffic path. Since VOD is a real time service, the additional latency and jitter can impact the quality of the video.

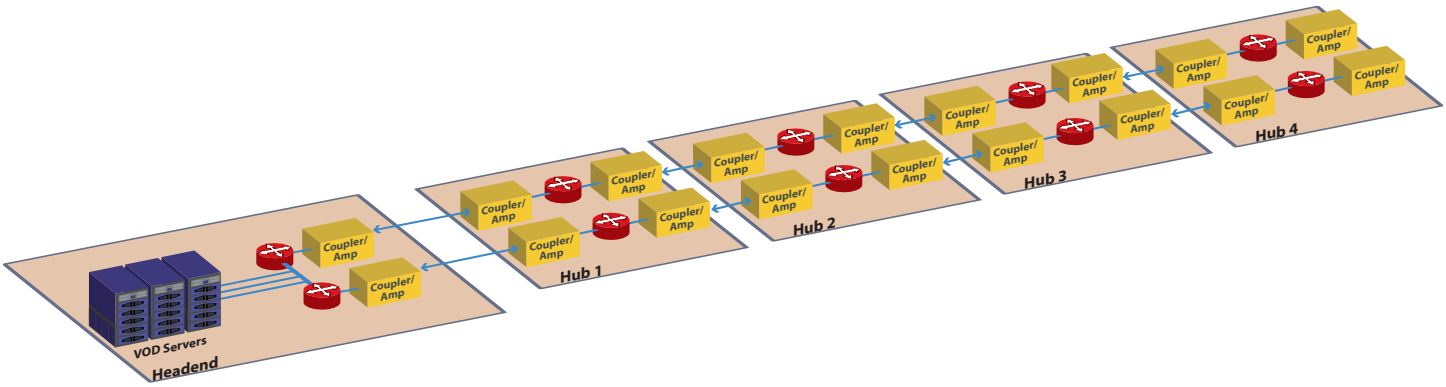

Figure 7: L2/L3 Video/VOD Network Example

A more cost effective approach for VOD services is to transport the streams over a ROADM network, as shown in Figure 7. The ROADM network essentially becomes a "Photonic Freeway" with express lane off-ramps at each Hub/VSO. Pass through traffic no longer consumes router interfaces and switch fabric resources at each intermediate node. In fact, many MSOs completely bypass the edge router at the terminating hub, connecting VOD traffic directly to a bank of QAMs.

Routers and switches remain key elements of any broadband services network, but they may not be the best choice for real time VOD traffic. The aggregation, switching, and routing features of L2/L3 platforms make them ideal choices for other services, such as cable modem and DSL data services, VoIP services, gaming, home monitoring, etc. The ROADM model, shown in Figure 8, included the cost of edge routers as part of the model precisely because these platforms are key elements to support broadband services.

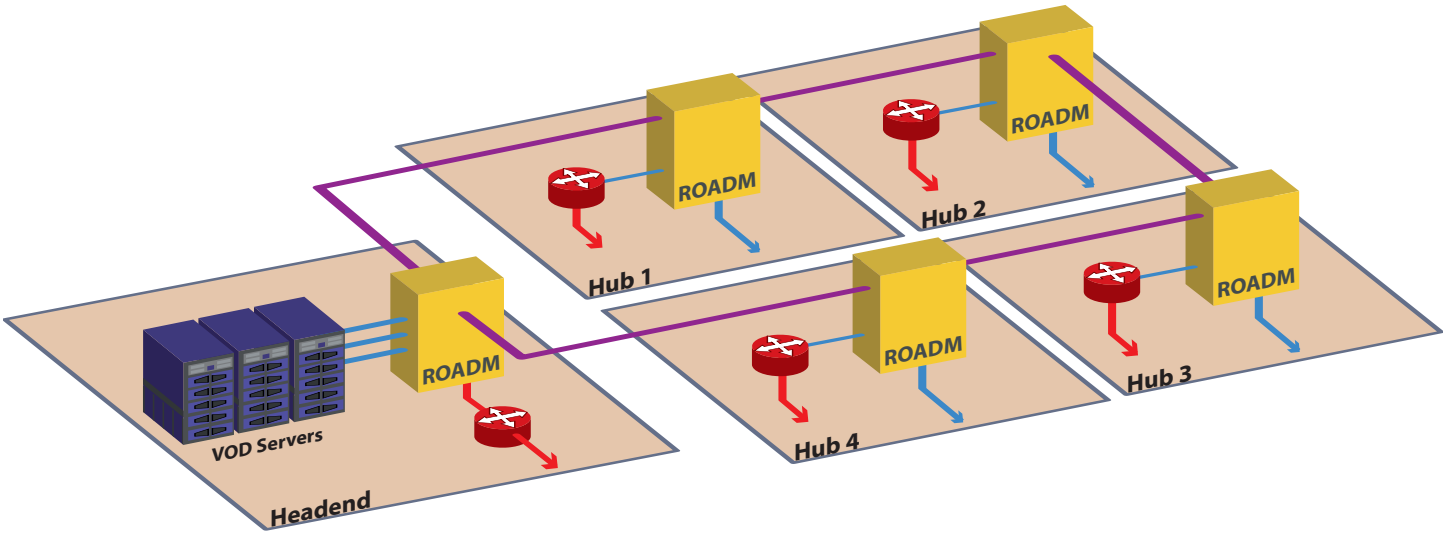

Figure 8: Metro DWDM VOD Architecture

Comparing the results of the two models shows a 45% savings when deploying a metro DWDM network for VOD services compared to a L2/L3 only architecture. The cost savings result from optimizing the network architecture so that each platform, metro DWDM and L2/L3 router, is properly matched to their application and traffic type. In other words, routers are used for those services that really require aggregation and switching/routing functions, while off loading those bulk services (VOD) that just require efficient, scalable and high capacity transport from the headend to the hub sites.

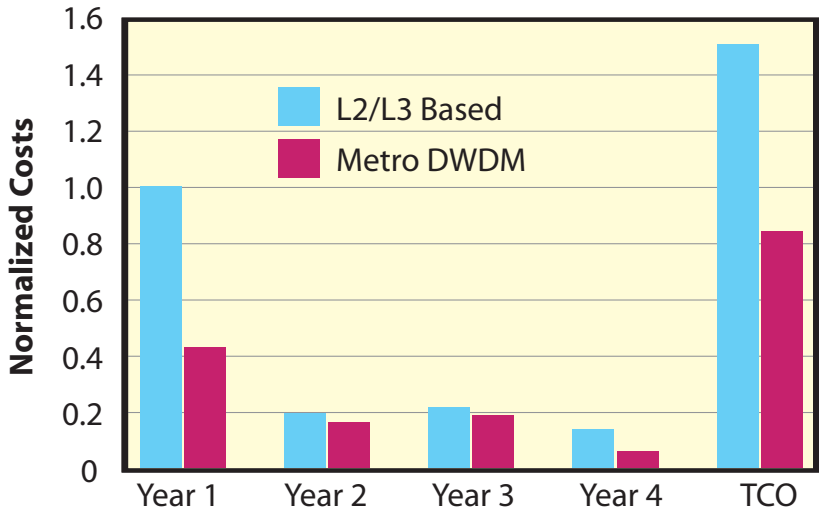

Figure 9: Total Cost of Ownership

Elimination of Overlay Networks

A metro DWDM network further reduces operating costs by eliminating the need for overlay networks. Most MSO networks employ multiple overlay networks, with each network or layer designed to support a single service, including:

• Digital Video	DVB-ASI
• Circuit Switched Telephony	DS1
• Business Services	DS1, Ethernet, SAN
• CMTS	100Base-T, GigE, OC-3, OC-12
• VOD	GigE

The FLASHWAVE 7500 platform collapses all of those services into a single, converged broadband network, eliminating the cost to maintain and operate multiple networks.

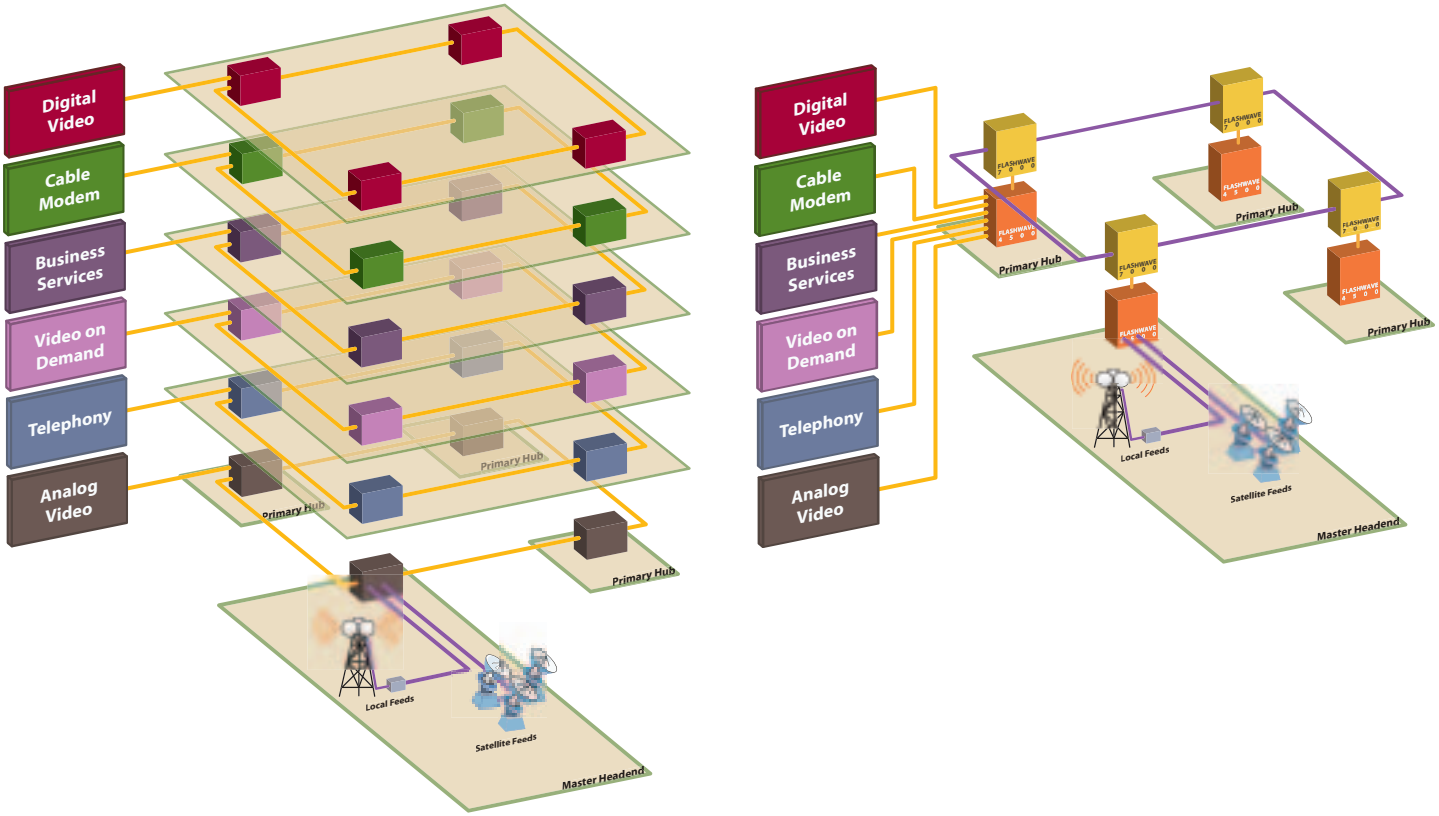

Figure 10: Overlay Networks

Fujitsu FLASHWAVE 7500—Metro Photonic Freeway

Key to the success of any VOD service is cost effective transport of hundreds to thousands of VOD streams over a core network using GigE interfaces. Fujitsu designed the FLASHWAVE 7500 ROADM platform specifically for high capacity video applications, including video on demand. The high-density Gigabit Ethernet Muxponder cards dramatically lower the per-stream costs of VOD networks. The FLASHWAVE 7500 auto balancing features ensure your network maintains optimal performance, without the cost and thousands of man hours of manual adjustments required on other DWDM networks. Widely deployed on several MSO networks, Fujitsu ROADM solutions provide proven performance, leading to superior business results. Benefits include:

- **Reduced Network Costs** – Offering the lowest cost per stream transport, the FLASHWAVE 7500 ROADM boosts bottom line profitability.
- **Revenue Growth** – Fujitsu ROADM networks offer new revenue generating services, including VOD, VoIP, Ethernet data services, legacy video services, and business services, all across a single core network.
- **Service Delivery** – Turn up services and wavelengths in minutes instead of the months required on other products. The improved service velocity means new services start generating revenue faster.
- **Reduced Operating Expenses** – Surprisingly, the largest cost factors for optical networks are not the initial equipment costs but the ongoing expense of operating and maintaining the network. Fujitsu provides advanced self-tuning and power balancing features to eliminate time consuming manual adjustments.

Figure 11: FLASHWAVE 7500 ROADM

The Possibilities are Infinite

In today's business environment, it's comforting to have a trusted partner. Fujitsu offers more than 60 years of proven experience and optical networking leadership. As a networking company with more than $45 billion per year in revenue, Fujitsu has the financial stability and technical development resources to ensure your network remains robust and profitable. Our resources are focused toward the single goal of helping build next-generation networks that offer dramatically lower transport costs, lower operating costs, enhanced service flexibility and faster service delivery. Fujitsu understands video, because we own and operate five cable networks!

The Metro Photonic Freeway is now available with the Fujitsu FLASHWAVE 7500 series DWDM platforms. With over 265 nodes deployed, Fujitsu is the industry leader in supporting VOD service and core network convergence for the MSO industry. *Power your VOD network with the industry leading Fujitsu FLASHWAVE 7500!*

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Acronyms

Acronym	Descriptor
CMTS	Cable Modem Termination System
DHUB	Distribution Hub
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
DVB-ASI	Digital Video Broadcast Asynchronous Serial Interface
DWDM	Dense Wavelength Division Multiplexing
GigE	Gigabit Ethernet
HD	High Definition
HFC	Hybrid Fiber Coax
L2/L3	Layer 2 switch / Layer 3 router
MOD	Movies on Demand
MPEG	Motion Picture Experts Group
MSO	Multiple System Operator
ROADM	Re-configurable Optical Add/Drop Multiplexer
OLC	Optical Line Card
PVR	Personal Video Recorder
QAM	Quadrature Amplitude Modulation
STB	Set Top Box
SVOD	Subscription Video on Demand
VCR	Video Cassette Recorder
VOD	Video on Demand
VoIP	Voice over Internet Protocol
VSO	Video Serving Office

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