BitBand Inc.
Video On Demand
Solution Overview

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1. Preface

This document is an overview of the BitBand solution to delivery of video and audio, in particular VOD, to IP network end-users.
This solution is based on BitBand unique architecture and implementation. As such, it is not the only approach to the design of VOD for IP-TV. We believe that our scheme offers significant merits, which position the BitBand solution as one to be seriously studied and considered, when planning VOD for IP-TV.
This document is intended to provide:

- High-level description of the BitBand solution for Executives and Managers and other non-technical readers in organizations planning to implement IP based video services, or otherwise connected to the industry.
- Introduction to the BitBand solution for technical readers.

For more details, please contact your local BitBand representative or write directly to: David Milloh, VP Marketing and North American Business at milloh@bitband.com.

2. Broadband and Video Content

2.1 IP, Video and VOD over IP

IP networks provide a unique way of offering a large, flexible and evolving variety of services over a homogeneous, low-cost and secure network infrastructure. Since the advent of the Internet, a growing number of end-users have enjoyed its long and wide reach, but had to live with relatively slow and unstable links, unfit for delivery of high quality rich content. The growing availability of high-end broadband is making it possible to deliver high quality, broadcast grade video over IP. These networks are referred to as ETTx (Ethernet-To-The-Home, Ethernet-To-The-Curb, Ethernet-To-The-Premises, Ethernet-To-The-Room. They can be implementation over a variety of physical network infrastructures which can carry IP protocols, some of which are already commercially proven, while others are used for pilots and trials only: fiber, copper Ethernet, wide area xDSL, local xDSL, DOCSIS over CATV, various wireless networks and power-line).
True real time On-Demand content delivery, especially Video-On-Demand (VOD), is considered by service providers to be one of the most lucrative value-added services, which can not only generate new revenue streams, but primarily leverage their competitiveness and retention, as part of the “Tripleplay” value added package (Fast Internet, Digital Telephony and Video), in the fierce competition for broadband-based services. The convenience of choosing and immediately viewing the desired video content out of large content repositories, without risking late-return fees, so common with video rental, promises high attractiveness and acceptance by customers and resulting new revenues and competitiveness for service providers. In today's competitive world, high quality On Demand services are quickly becoming natural, and soon mandatory, elements of service packages over broadband ETTx networks. VOD services are usually offered to end-users as the most lucrative part of a complete interactive TV (iTV) service, which consolidates and integrates live TV and radio channels, pre-scheduled Pay Per View (PPV) broadcast of TV programs and movies, T-Commerce and Gaming. VOD can be offered in a variety of ways such as Pay Per Movie and Subscription VOD (SVOD). BitBand core offering is a unique platform for delivery of VOD and NVOD.

Commercially successful IP-TV depends on offering the consumer the right mixture of content, including new and popular movies and TV series. Content providers make such content available to the service providers only if reliable content protection schemes are implemented. In addition to the video delivery platform discussed in this document, BitBand offers **SecureStream™** – software based lightweight end-to-end content protection solution. SecureStream is discussed in detail in other documents, which are available from BitBand.

Most traditional providers of IP services over xDSL lines are entering this field by performing technical and commercial trials, positioning themselves to shortly launch large scale services, as the gap between their xDSL network speed and the high quality content bit rate closes. The new paradigm of offering value added services over IP networks also brings new competitive players, such as utilities, municipalities and residential communities, which can employ their modern, mostly fiber, network infrastructures to their advantage.

The technologically more challenging mode of video delivery is VOD – large number of discrete unicast high bit-rate streams, initiated and controlled by individual end users. At the same time, this technology is also the most versatile in its ability to evolve and provide advanced applications and services such as network based PVR and more.
In order to provide high-quality On Demand service, the service provider must have a reliable and cost effective content delivery or “Streaming” subsystem. This will be our first topic.

2.2 The Network's "Edge"

In most residential network environments, centralized networks, which use a single head-end located at the data center, do not scale well enough to guarantee smooth and consistent 'unicast' VOD streams to the multitude of viewers. Therefore distributed "Edge" network solutions, commonly named "Last-Mile" (termed "First-Mile" by the IEEE 802.3 Task Force) bring content and streaming engines closer to the users.
The actual "Edge" may take various shapes and employ different technologies.
All wide area IP networks cannot cope with the bit rates required to transmit large numbers of discrete unicast high quality video streams.
With newly laid fiber, the issue is somewhat less acute. Still the backbone rings branch into peripheral ones, over which switching and bandwidth management can be accomplished. These sub-rings form the Edges.
With ADSL, bandwidths which enable video grade speeds, are available today mostly close to the DSLAMs. The DSLAM centric sub-networks form the "Edges".
In some industries, such as hotels, hospitals, housing complexes etc, the network, business and operational structure mandate that each entity (hotel, hospital, MDU, campus…) is an Edge in its own right.
In general then, the Edge will be a distributed IP enabled Point Of Presence (POP) with its sub-network, serving a small town, a city quarter, a building complex, or an intra-building local network. Edge solutions necessitate a network of distributed servers to receive, store and stream the content. The solution must technologically and economically fit the specific system scale, topology and growth rate, over several disciplines and operational aspects described in the following paragraphs.

2.3 The IP based TV and VOD Client

End-users must possess client devices, to control the video streams and display them.
In the corporate environment, end users use desktop or laptop PCs as their primary information access tool. They are trained to use PCs and have quick access to system administrators and technical support staff. In the corporate environment, video is an additional means of providing corporate or industry information. Obviously, the same PC is the platform of choice as the corporate client device.
On the other hand, in the entertainment centric video industry, the average consumer is used to watch video in the comfort of his living room sofa, home theatre, bedroom, hotel room or hospital bed, using a remote-controller. Many video consumers cannot operate a still far from friendly and intuitive PC, especially a sophisticated one, such as is needed for playback of high quality video.
The future may hold the promise of an integrated home entertainment system, but all attempts have thus far not passed the ultimate test – provide a tool that the consumer would like to use and is prepared to pay for.
TV sets, equipped with stand-alone or embedded Set Top Boxes (STBs), are therefore the clients of choice. Some video content will be watched by PC users, either on their screens or connected to TV sets. A number of such services are in existence for 'download on-demand'. Still, they have not yet passed the test of a scalable commodity service, with reliable end-user support, as required by the stringent demands of high-quality image.
From the service provider point of view, providing broadcast-quality service and support to end users mandates the use of client devices, which are stable, centrally controlled and secure. A television service provider cannot cope with problems arising over countless combinations of hardware and software elements found in PCs.

2.4 The IP Video Content Format

In a PC centric world, clients are populated by a multitude of applications, plug-ins and applets, and support staff is close at hand. In such an environment, proprietary content formats and their proprietary players are acceptable. This is also true because most business oriented and internet based video content is low quality and does not mandate DVD quality full screen view.
In the entertainment world, paying subscribers demand large screen, DVD quality video image and the content providers mandate quality level equivalent or better than DVD for prime titles. Hence, using formalized content format standards (the MPEGs) is generally preferred. In addition, employing formal industry standard content does not create a reliance on specific platform vendors, in both the hardware and software parts of the STB.
At present, DVD-quality MPEG-2, at relatively high bit rate, usually 3.5-5.5 Mbps, is used for most content, especially for recent and prime releases. Much of the drive towards IP-TV comes from the Telco world, predominantly ADSL based, where such bit rates are usually prohibitive, except for metropolitan areas. The effort to bridge the gap between DVD quality content and the average ADSL subscriber line speed drives the industry to seek faster networks and leaner content formats. MPEG-4 is widely regarded as the solution. MPEG-4 content delivery is demonstrated by many vendors of encoders, servers and STBs, but quality is still below what MPEG-2 offers and popular content is still not readily available. Most vendors of MPEG-2 encoding devices offer advanced high-quality encoding at 1.5-2.3 Mbps. Formal standard MPEG-4 (ISO part 10 or H.264) is expected to be commercially available in mid 2004, driving bit rates down to the sub 1Mbps. Microsoft Windows Media Technology® is regarded as the gap-stopper till ‘standard’ MPEG-4 is generally available.
The growing interest in delivering HDTV adds to the pressure on the content and network bit rate gap.

2.5 The IP based VOD must-have list

Having laid the foundation to understanding the environment of VOD and video over IP, and the utmost importance of the VOD delivery system, we can explore the characteristics and features, which must be part of an On Demand content delivery system. As the rest of this document will show, BitBand excels in providing solutions that answer all of them.

2.5.1 Scalability and Affordability

Providing converged services, including video, over high-end IP networks is a relatively new industry. As such, it is characterized by small business-model trials and then gradual introduction of commercial service in limited and then growing geographical distribution. In addition to large operators, such as the incumbent Telcos, this industry introduced new players. These include local, regional and nationwide operators, using networks provided by local Telcos, energy companies, other utilities and local governments.

The characteristics of such industry mandate both modest entry levels and virtually unlimited scalability. For the service provider, this must also be translated to cost structure, allowing it to spend on delivery platforms only as much as is required at any point in its deployment and business plan, at the same time able to grow fast at unexpected pace, upon market demand. In today's risky and highly competitive economy, this is a compelling factor. Relatively small subsystems are also required for servicing distributed small to mid-sized locations, as part of large operations.
The server platform should offer a low entry cost, seamlessly and quickly growing to virtually any scale required. This growth process is best done by adding modules to the already existing ones, not interrupting their operation and service, also preserving the investment in them.
Costs must be driven down not only at acquisition time. The system should be easy to implement, operate and administer. These aspects are further discussed below (Serviceability, Administration, Management).

2.5.2 Service Reliability, Stability and Security

Although we are discussing services provided over remote access IP networks, these are not "Internet like" services, which we have grown to accept as unreliable and unpredictable. This is the world of TV broadcast. Service to the end user must be reliable and predictable, as we expect from terrestrial and cable TV providers. Failures must be minimized, and those that occur – contained and handled in a way, which will not affect active service or disrupt it. The platform must allow deferred maintenance, to allow its distribution to remote locations.
To accomplish this, the delivery system must have a comprehensive suite of characteristics and features: advanced network protocols, robust client-server interaction, reliable hardware and software and automatic fail-over mechanisms.
The platform must also protect itself, the content it stores and the operator's data center from any intentional or unintentional break-in, damage and theft. Content protection, mandated by content providers, is essential in acquiring popular content.

2.5.3 Serviceability

Even when implementing the best technology and design, malfunctions will sometimes occur. As discussed above, the nature of the VOD delivery network entails a high level of server geographical distribution. This poses challenges in maintenance and serviceability, which must be brought to a minimum, in order to keep operating costs and complexity reasonable. In fact zero preventive and on-site maintenance is a necessity, if we wish to deploy servers into a remote DSLAM, apartment buildings and hotels.
In addition, provisions for deferred maintenance of failing components must be available. Alarms and notifications of imminent and actual failures must be generated.

2.5.4 Platform Administration

Servers comprise of hardware, operating system and applications. Most hardware-operating systems platform combinations require constant systems administration and tuning activities, to keep their performance and availability at the levels required.
With Distributed VOD servers, it is much preferable to use platforms, which have been specially designed to minimize these efforts or even nullify them.
This can be best achieved by using appliance-type devices.

2.5.5 Management and Control

Operating multiple servers, especially when they are highly distributed, also mandates effective management tools. These management tools should make status and operational information available, presenting the Edge segments as unified logical entities.
Information should be made available both in real-time and as cumulative detailed log files.
Alarms and notifications of imminent and actual failures should be reported to the data center, with automated handling of some situations.

2.5.6 Interoperability – Data Center

The content delivery system is a part of a complete integrated iTV solution, and must interface and interoperate with several other components of the system, such as Content Asset Management, iTV Management Applications ("Middleware"), Network Management, Billing, Customer Care etc.
This interoperability can be implemented using APIs and/or shared access standard databases.
Since such interfaces have yet to be standardized, it is important to at least use formalized standard content formats and network protocols.

2.5.7 Interoperability – Client

STBs vary in their hardware and software configurations. In order for them to interact with the video delivery system, especially VOD, where the end user can Pause, FF and REW, create bookmarks, support network based recording etc, a VOD server-dependent software client must be integrated into the STB software. Advanced client-server interoperability can also be used to provide superior Quality of Service (QoS). This is detailed in the following sections.

3. BitBand VOD Solution

BitBand objective is to offer the service provider a best of breed solution. It should enable services that attract subscribers and keep them happy and satisfied, contributing to the service provider's revenue, at the same time keeping costs down, with the best price-performance available in the market, and extremely low startup effort and cost.
Employing its highly modular system architecture and implementation, BitBand is in a unique position to offer high-quality and cost-effective solutions to service providers in all IPTV market segments:

- Large scale Telcos and large Next Generation Service Providers (NGSPs)
- Regional and local NGSPs and operators
- Hospitality, Healthcare and the Multi Dwelling Unit (MDU) market segments
- Education, retail etc.

The following description of BitBand solution provides a high-level answer to each and every point mentioned in the previous section as requirement for a successful implementation of VOD.

3.1 BitBand Vision Servers

3.1.1 Architecture: Modular Building Blocks, Managed in clusters, Driven by Intelligent Clients

BitBand Vision servers are autonomous devices, containing powerful streaming engines and internal storage subsystems, both optimized to provide stable high-performance streams at low cost.
BitBand Vision servers are used as **building blocks** to form powerful, scalable, serviceable and low cost content delivery **clusters**. Clusters serving a region are managed and operated as entities, thanks to BitBand Maestro Content Distribution and Server Management Suite.
In the BitBand unique concept, video streams are initiated, driven and managed by the **Intelligent Client**, embedded in the STBs, offloading stream management from the servers and contributing to QoS.

3.1.2 Implementation: Appliance Servers

BitBand Vision VOD servers are implemented as compact network attached **Appliances**, designed for simplicity and robustness, using an embedded real-time operating system, which has been optimized by BitBand for high-performance low-overhead video streaming.
The Appliance implementation renders the service provider totally free of server maintenance and system administration tasks, which are required when using complex hardware server implementations or software video streaming implemented over standard IT oriented computing platforms. BitBand Vision are true Plug & Play appliances, which one plugs to the mains and to standard network switches.
Vision hardware is assembled by BitBand, employing carefully chosen standard off-the-shelf computer components and real-time operating system. This allows BitBand to offer optimal performance and robustness, keeping the platform open and standard, enjoying the market's cost reductions.

3.1.3 Applications: VOD, NVOD Broadcast, Audio and more

BitBand Vision servers provide unicast VOD services - the more technically challenging mode of content delivery, as well as video multicast to the general user population, for NVOD services.
Audio On Demand and Radio Channels are also provided

More functions are available as optional features:

- HDTV – high bit rate (up to 24Mbps) for HDTV
- SecureStream – A lightweight, yet comprehensive, end-to-end content protection by software scrambling.
- NetVR (Network video recorder) - ingestion and recording of live broadcast onto disk, making the recorded content available as VOD or NVOD
- ShifTV - time Shifted recast of recorded material), based on NetVR technology.

3.1.4 Server Models

BitBand Vision 190 series are ultra compact 1U field proven workhorses, of which several hundred have been commercially deployed. They are field proven in central and distributed Telco deployments, as well as in highly distributed hospitality services. Vision 190 series have undergone several software and hardware enhancements and will continue to be enhanced, remaining a basic building block of the BitBand offering. They offer the ideal solution for trials, small DSLAMS/headends and for the hospitality and healthcare market sectors.
Derivatives currently offer streaming rates between 25 to 70 high quality video streams at 3.5Mbps and store between 45 to 285 hours of DVD quality video.

In 2002 BitBand introduced its Vision 480 server, targeted at large operators. Today, the compact 2U Vision 480 streams up to 140 concurrent 3.5Mbps video streams and stores up to 570 hours of content.

Figure 1: Servers

BitBand is committed to enhance its building blocks in both streaming rate and content storage.

Clusters of these building blocks can store many terabytes of content and deliver it in a mass of simultaneous streams.

3.2 BitBand Maestro Content Distribution and Server Management Suite

Maestro has three distinct tasks:

1. Content Distribution from central Content Asset Repositories to the BitBand Vision servers, at the central and various distributed POPs.
2. Managing Vision servers:
   - Integration of regional clustered servers into managed entities, in terms of content distribution and management, streaming power aggregation, fault handling, operation and service.
   - Display and reporting of servers' status, utilization and abnormal conditions.
   - Consolidation of server generated logs into a comprehensive system log.
3. Interoperability between the BitBand system and other components of the iTV system, such as iTV Management Application, Media Asset Management systems, satellite content distribution systems etc.

BitBand Maestro allows the content administrator to define the various content delivery system resources, such as servers, clusters and their network topology (regions), media asset repositories and content attributes.
It then enables the planning of the various content related processes and their execution – immediate or pre-scheduled.
Content distribution and management processes are synchronized with iTV Management Applications, using Maestro API.

Optimized distribution to remote regions and clusters and to individual servers within them is performed under BitBand Maestro's direction, optimizing network resource usage. To the network and resource administrator, BitBand Maestro provides real time and log based monitoring and collection of all server resource information and activities, beginning with indications of failures, through storage usage and number of users serviced and actual bandwidth provided, ending with detailed information on temperatures and voltages in various server components. All this information is saved in an SQL Data Base for system management, statistics and history reports.
Maestro allows optimal distribution of content assets in a distributed server network, where bandwidth and storage resources need to be dynamically balanced.

3.3 BitBand Client

BitBand provides its intelligent Client SDK for easy integration into partners' STBs. Integrations with many leading STBs exist and are deployed in customers' networks. Additional integrations are underway, while more can be performed according to customers' preferences.

As mentioned above, BitBand architecture distributes the responsibility of managing the stream and its QoS to the client. BitBand Client implements this, managing server load balancing, server fail-over and streaming dialog with the server.
The BitBand client is a flexible integration point for further QoS based developments. BBPlayer, a PC client, based on software decoding is also available.

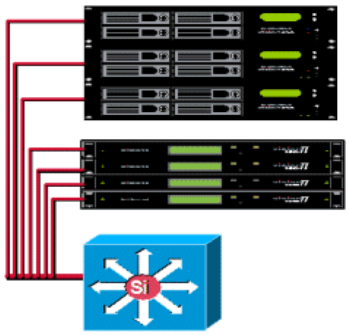
3.4 How the BitBand Solution Works

BitBand Vision technology was designed from the ground up for the specific task of streaming rich content over broadband. BitBand Vision servers are based on an integration of an optimized real-time kernel operating system with a proprietary application, over a robust, yet simple and low-cost, hardware platform. This unique combination provides Broadcast/Carrier-Grade performance, reliability and security, at the same time eliminating costly overheads. Each server is a self-contained storage and streaming unit. BitBand proprietary file and streaming technologies ensure continuous streaming and guaranteed performance to all connected users.
BitBand Vision servers deliver unicast and multicast streams, implementing industry standard network protocols.

BitBand also provides specially customized streaming solutions to customers who imbed BitBand Vision servers in existing complete systems and to provide solutions for other special requirements.

3.4.1 Scalability – from a Small Entry to the Virtually Unlimited

Three key factors contribute to the BitBand solution unique scalability range:
1. The building block concept inherently provides low entry point and seamless gradual growth to virtually unlimited scales. This allows service providers to gradually use their resources and acquire their delivery platforms as subscriber base and business grows. Scalability is achieved by stacking servers in clusters. Server clusters are self-configuring, requiring no action except connection to the same sub-net. This form of scaling-up is seamless, protecting customer investment in the existing system, allows uninterrupted service while servers are being added or removed and offers flexibility in configuring headends according to changing requirements.



Plug&play clustering over standard Ethernet networks
- Utmost simplicity for low TCO
- Virtually unlimited scalability
- Resource balancing
- 'Any component' fault resilience
- 'Buy as you grow'

Figure 2: Server Clustering

2. Single servers or small clusters can serve small establishments or communities, while several co-located clusters can be grouped to serve large populations of end-users, providing virtually unlimited scalability.

From the content management and service administration point of view, any such small or large group of servers ('region') is regarded and managed as an integrated

system. All content distribution activities are thus simplified, rendering the "building block" architecture virtually transparent to the content administrator.
Some network topologies call for placement of servers at the extreme edge of the network – namely Hotels, hospitals and MDUs. The BitBand solution fits this extreme distribution very effectively, employing small clusters.

3. It is rare that a single architecture can so effectively serve such a wide range of operational scales. One of the prime factors contributing to this is the unique design BitBand chose to implement in managing video streams and their QoS:
Given the large number of streams served by the server, stream management, integrity and fault resilience is usually managed on the server side, creating additional load as the number of streams grows and, in most cases and despite the use of advanced and costly redundant storage, precludes guaranteeing the stream's survival when complete servers break down, or multi-component failures occurs.
BitBand architecture offloads the responsibility and the task of managing each stream's integrity and QoS to the Client, integrated in the STB.

3.4.2 QoS, High-Availability, Fault Resilience and Serviceability

BitBand solution is designed to provide several layers of protection against service disruption and degraded QoS:

- The innermost layer takes care of stream integrity and stability, employing robust network protocols and BitBand intelligent and active Client. Together, they enable the Client to maintain robust content streaming and overcome transient network problems and packet loss.
- The second layer provides real-time server fail-over mechanism, by which the BitBand Client, sensing a disruption in server streaming, due to whatever reason, automatically switches to another server in the cluster.
- The third layer allows the service provider to disable a failing server, and enable a standby spare server, using Maestro.
- When convenient, the failing server can be exchanged by non-technical personnel, with a fresh one, to be automatically re-loaded with content and enters the standby status.
- If a rare multiple server failure occurs, region/cluster streaming capacity is degraded by only one server throughput (note that active streaming sessions have already been switched to active servers upon each server failure).
- Further means of containing faults, automating reconfiguration, minimizing system impact and repair time, are due for release in forthcoming versions.

This sophisticated level of containing transient and permanent component failures is a result of BitBand's inherent design for QoS and robustness, without deviating from its concept of optimized use implementation of simple and low-cost hardware platforms.

3.4.3 Minimal Staff and Technical Training

Since no server platform maintenance and systems administration tasks are required for the true Plug & Play Vision servers, costly professional hiring and training is minimized. Productive content provisioning, distribution and management become the major task of the service providers' staff. Initial server installation as well as field servicing – exchanging servers in a rack, can be performed by non-technical personnel

3.4.4 Management and Control

Routine operation and management are performed using BitBand Maestro Content Distribution and Server Management Suite.

Maestro has three distinct tasks:

1. Content Distribution from central media asset repositories to BitBand servers, at the central or distributed headends.
2. Managing Vision servers:
   - Integration of regional clustered servers into entities, in terms of content distribution, streaming power aggregation, server management, fault handling, operation and service.
   - Display and reporting of servers' status, utilization and abnormal conditions.
   - Consolidation of server generated logs into a comprehensive SQL based system log.
3. Gateway for interoperability between the BitBand system and other components of the iTV system, such as iTV Management Application, Media Asset Management systems etc.

Maestro provides centralized interfaces and tools:

1. Definition of content assets (video and audio content items, their source location and categories) and network resources (servers, clusters and regions) and their topology.
2. Definition of logical groups of assets and resources to enable provision of different content assets to different network resources for different locations or populations.
3. Definition, scheduling and initiation of content distribution operations.
4. Application Program Interfaces (APIs) to iTV Management Applications, to synchronize asset distribution with .
5. Real-time information display of the resources Maestro manages.
6. Retrieval and consolidation of servers' logs from servers into an SQL based system log.
7. Optimization of content distribution over network resources.

3.4.5 Logging and Reporting

Vision servers record all operational and service parameters and events. These logs are retrieved and consolidated by Maestro into its SQL database, and may be used for statistics, resource management and planning and some billing schemes.

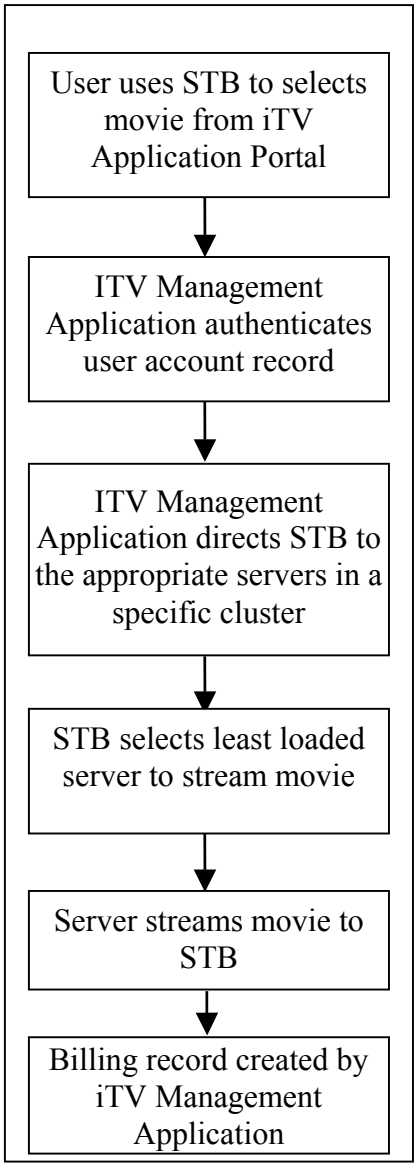
3.4.6 Interoperability

Both Vision and Maestro are designed to interoperate with a customer environment that contains other components of the streaming system, such as Set Top Boxes, Media Asset Management, iTV Management Application Middleware etc. Industry standard protocols and file formats are used, to ensure interoperability and easy integration.

4. Architecture

4.1 Components and Flow

Assuming a client to server ETTx network with sufficient bandwidth exists, the typical VOD over IP service includes the following main components and interactions (reefer to figures 1÷4 below for components and network layout reference and the chart on the right as schematic flow diagram):



4.1.1 iTV Management Application

iTV Management is an application software, which resides in a central server located at the service provider data center. It uses clients in the STB (as client code and/or as web based HTML and JavaScript). The iTV Management Application manages the various iTV services, including VOD, displaying its portal menus on screen through the STB. It interacts with other applications: Customer Care, Conditional Access, Billing, Media Asset Management, and the Video Servers Management Suite (Maestro). Listing of content available for VOD and its descriptions are displayed. The iTV Management application authenticates the user's identity and eligibility to receive the service (and the specific item chosen), and directs the STB client to the appropriate server region for stream play-out,. Following the termination of the streaming session, the appropriate billing event is reported.

4.1.2 STB (with BitBand Client)

Located at the end-user's home (or hotel room/hospital bed) connected to the IP network by an appropriate network adapter (Ethernet, ADSL…) and to the TV set (or embedded in it).

Using the STB embedded iTV client to access web pages and applications provided by the iTV Management Application, the user identifies himself and authenticates his eligibility to use content. Using selection menus the movie is chosen and the STB client receives the list of applicable servers storing the specific media asset. The BitBand Client embedded in the STB chooses the least loaded server and initiates the streaming session.

The STB manages the session, including fail-over between servers, in case of server malfunction.

4.1.3 VOD Server (BitBand Vision)

The VOD server is located at the center, headend or edge of the service provider network, depending on the network architecture. The server receives content from Maestro (or any FTP client)[1]. The server provides the video stream upon STB request. The server logs all events and status information.

4.1.4 VOD Server Management Suite (BitBand Maestro)

Maestro uploads content to the servers, according to iTV Management Application instructions, passed to it through API.

4.1.5 Media Asset Management

This is an application usually found at broadcasting operators for managing the acquisition, programming, digital rights and metadata of content.

4.1.6 Content Repository

Various media storages hold all the content, from which selections are made for delivery and distribution to servers, for end users to watch. If a Media Asset Management System is present, it usually manages the repository. Maestro retrieves content for distribution from the repository, upon iTV Management Application instructions to distribute assets.

4.1.7 Billing System

Either a specific billing system for iTV services, or a mediation application, integrating the iTV billing records into a general purpose billing system. This is the case where the iTV service provider is a part of an organization such as Telco or an energy company, consolidating all its billing.

4.1.8 Network Management

Many large network operators employ network management tools, to manage and control the communications network itself. It is possible to link Maestro into such tools to consolidate the reporting of all physical network entities.
It is also possible to interact with the Vision servers for management purposes using SNMP.

[1]Recording of live broadcast content is available as an optional feature

4.2 Network Architectures

One of the important factors for the VOD service success is the network. The network must reach all end-users at speeds and QoS compatible with the content to be delivered. This entails usage of a wide variety of network schemes and components: Fiber, wide area DSL, local area DSL or Ethernet, all at various speeds.

4.2.1 Centralized Networks

In the broadcast industry, programs are prepared for broadcast and than transmitted as preprogrammed channels from a central location over the network to all subscribers.
Due to the high demands VOD puts on bandwidth, with each user requiring its own data stream for his self created 'program', centralized topology can exist only when a very high-speed infrastructure is available, typically FTTH or FTTC solutions serving a large city, with each trunk serving a dense urban area.
Large clusters of BitBand Vision servers are then located at the Central POP in the Data Center, storing and streaming all content available on-line from a centralized central content repository in a single location.

Figure 2 depicts such a network.

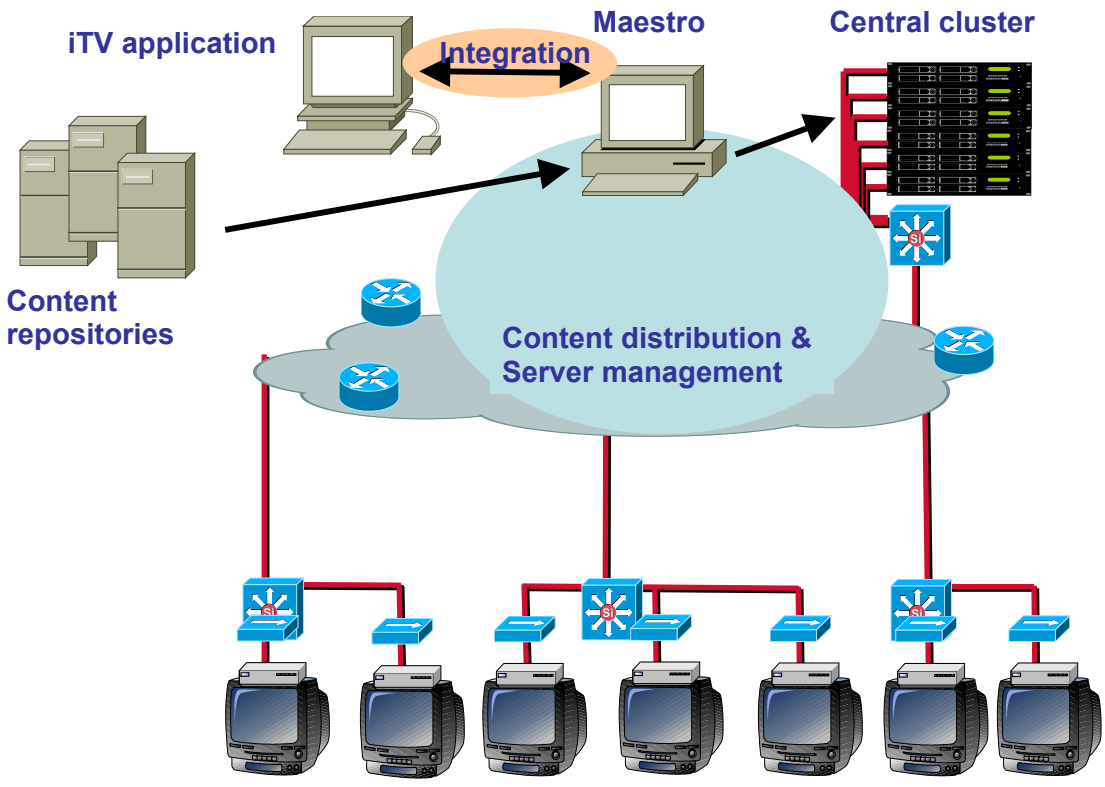


Figure 3: Centralized VOD network

4.2.2 Distributed "Edge" Broadband Networks

In all other network architectures, such as fiber networks serving several cities or DSL networks, the service provider will usually distribute the high bit-rate streaming resources away from the center, to distributed POPs, over smaller sub-networks, each serving a region. BitBand Vision servers can be easily distributed to these sub-networks' distributed POPs, which are dubbed the "Edge". The Broadband service provider than uses the backbone only for distribution of content from the central repository and for control purposes. Storage and computing platforms are today cheaper than bandwidth. "Edge" networks will probably be more common than centralized networks, and are in many cases the only feasible solution.

Such topology also allows for flexible scalability, by providing both vertical and horizontal growth paths: vertical – by using larger server building blocks, horizontal – by using multiple clusters of servers, managed by Maestro. This is especially critical where network trunk limitations are approached and the only feasible method for scaling it up is through adding more distributed POPs.

As described above, BitBand Vision servers, together with BitBand Maestro, have been designed to cope with this need and therefore cost-effectively enable such network topologies, as depicted in Figure 2.

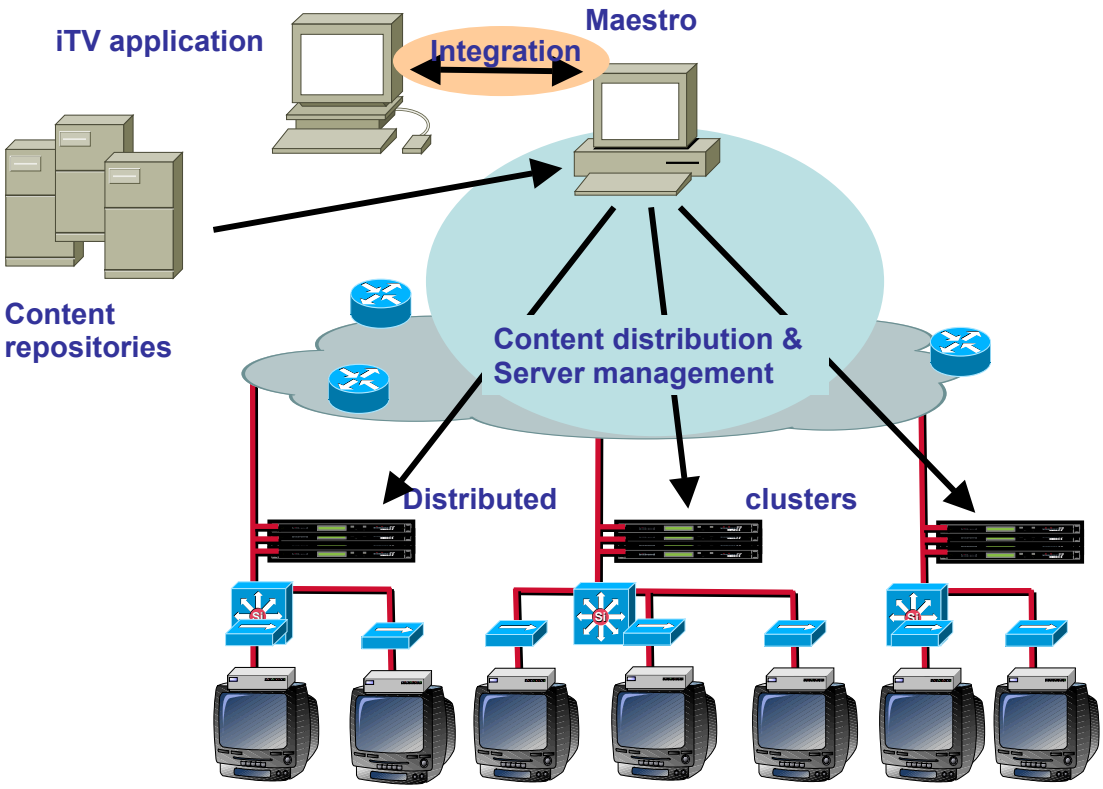


Figure 4: Typical "Edge" distributed VOD network

4.2.3 Hybrid Architecture

In many cases a combined central and "Last-Mile" architecture (Hybrid) is the most effective choice. As a matter of fact, with the Hybrid architecture service provider draws on the advantages of both architectures. Some of the servers are located at the center and some at the "Edge", according to specific requirements and optimal use of network resources.

Another way of employing the Hybrid topology is to allocate the central and distributed servers to different content types: The "Edge" servers can contain the most popular content and provide most of the streams, while the central servers contain the less popular content. Because the usage of such content is relatively low, they do not overload the network. In some cases low usage content assets consists of several thousands of video archive hours, making the hybrid architecture the most cost-effective solution.

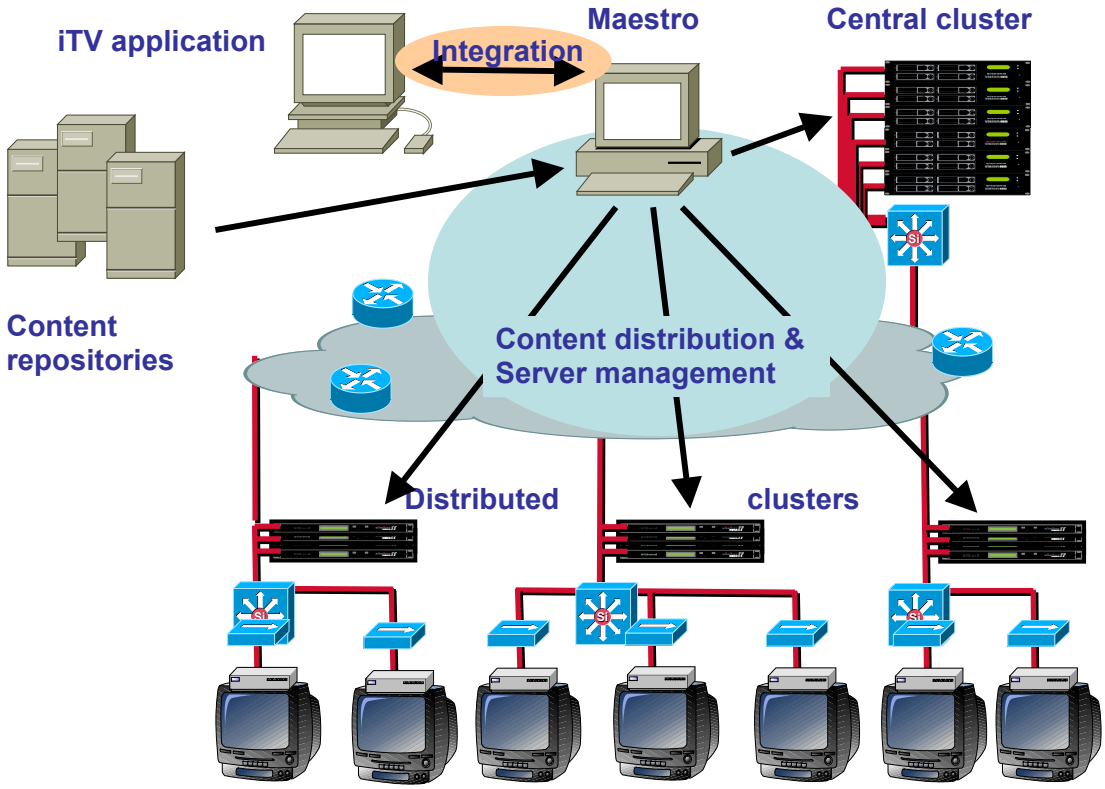


Figure 5: Typical Hybrid VOD network

4.2.4 MDU, Hospitality and Healthcare

In many parts of the world, people live in various high-density residential environments. These can be apartment buildings, complexes consisting of groups of such buildings, and other types of housing arrangements, all constituting grouped potential subscribers in a relatively small area, sometimes separated and even far from other such groups. Many housing contractors today provide networking and communications infrastructures, including broadband. There are also operators and service providers who specialize in providing infrastructure and/or services to such housing environments, sometimes through the property owners. These are designated by the acronym MDU – Multi Tenant Units.

Hotels, and hospitals, where a relatively large number of users share the same building complex share the same networking environment as MDUs, although they have specific requirements for iTV Management and content.

In a typical MDU, hotel or hospital it is cost effective to deploy local communications and networking facilities, including local application servers, such as VOD, to locally serve the end-users. Thanks to the low entry in both sizing and cost, multiple small BitBand Vision clusters will effectively serve each such facility. A typical deployment is depicted below.

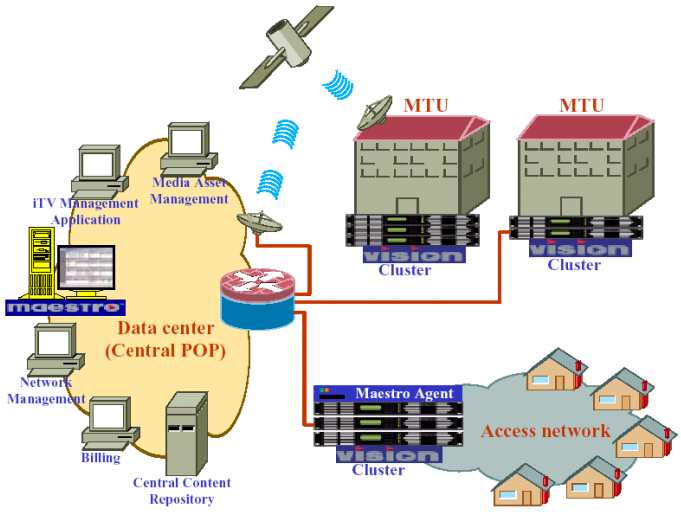


Figure 6: Typical MDU VOD network

Hotel and hospital deployment differ in the way they operate by locating the iTV Management Server or its distributed agent on-site, to interact with local systems, such as billing.

Content delivery to MDU and hotel/hospital systems can be accomplished using satellite links. This is extremely effective in remote areas.

IP services to these segments are today still mostly limited to Fast Internet access, while video is mostly still provided through separate analog systems, but the advent of low cost high-speed localized IP solutions now enables the provision of fully converged IP services, including video and VOD.

This topology offers a giant leap for satellite video service providers, enabling true VOD, by using IP "Edge" as the edge of the satellite broadcast infrastructure.

5. More BitBand Features

5.1 Network Security

Securing the data center and distributed POP from attack originating from the Last-Mile is a crucial issue for a service provider and should be given much consideration before deploying servers in the network. BitBand Vision server has an internal security mechanism to assist the service provider in preserving network integrity and security. This is a combination of employing separate network interfaces: one for video streaming and another for content upload and management, together with software design.

5.2 SecureStream – BitBand content protection (separate add-on product)

BitBand SecureStream is a comprehensive end-to-end content security scheme. SecureStream is a lightweight minimal integration solution, complementing the BitBand content streaming platform.
The complete SecureStream scheme provides:

- SecureVOD - real-time scrambling of VOD streams produced by Bitband Vision servers.
- SecureLive - real-time scrambling servers for live streams produced by 3rd party encoders/streamers.
- SecurePE – offline pre-encryption of video files.
- SecureClient – the software STB embedded descrambler

All these processes are performed by software, without the need for hardware implements such as smart-cards
SecureStream V2, a lightweight, minimal integration version, can be implemented as:

- Stand-alone zero-integration entry, allowing extremely quick implementation and time-to-market.
- Interaction with the iTV application in performing conditional access (CA) and accordingly distributing session-based keys to the clients for descrambling content.

As is the case with BitBand Vision servers, SecureStream is an enabler for the IP-TV industry, providing an advanced, efficient, scalable, easy to integrate, implement and operate solution to content protection, which is an essential part of making IP-TV come true.
SecureStream has originally been developed by BitBand for VOD, in response to a customer request. This serves as an example of how BitBand accommodates customer requests and requirements. In June 2003 BitBand made SecureStream V2 available, a lightweight version of the SecureStream complete end-to-end concept. V2 is unique in its ability to be added to the BitBand system (servers and clients) with no or minimal integration with iTV applications – a true “quick time to market” immediate solution.

More information on BitBand SecureStream V2 is available from BitBand.

5.3 NetVR and ShifTV (optional features)

What happens when you get stuck in traffic and arrive home 10 minutes late for the evening's main newscast, or miss a major sporting event due to a meeting? What about the kids having to do their homework when their favorite TV series is running? How about having guests when your long awaited classic movie is finally on? Or would you like to go back to a previous scene while watching a broadcast?
BitBand has released its server-recording feature, as a technology base to full Network based PVR capability, as an integrated function of BitBand platform technology and the iTV application management.

Using these capabilities, the service provider can record live TV programs and make them available On Demand or to broadcast them at predefined schedules, both even when the live version is still running.
Vision servers record and recast streams according to service provider's definitions. The service provider will program these through the iTV Management Application.

BitBand NetVR (Network Video Recording) application allows the service provider to record live MPEG streams from multicast or unicast sources onto the BitBand Vision internal storage disks, and make them available immediately for On Demand streaming or re-broadcast, even while the live broadcast is still in progress.

5.4 HDTV (optional feature)

High Definition TV acceptance is growing. As with DVD quality TV, HDTV becomes a mandatory feature for VOD to compete.
BitBand supports HDTV with streams of up to 24Mbps.