IPTV AND OTT PRIMER

Business and Technology Considerations for Establishing an IPTV or OTT Business

December 19, 2016
This document is intended as a check list for major topics that require consideration before launching an IPTV/OTT business

- Not a *How-to-Guide* but rather a *Think-About-This-First Guide*

It deals with Business and Technical issues and while mostly distinct per category, sometimes the lines (and eyes) blur

Never has technology been so in favor of smaller operators

- Intense IP video technology competition leads to lower prices
- Great choice in all systems categories, HW as well as SW
- Standards compliance means that products are interoperable
- Price/performance continues to develop very favorably

DVEO has a long history of assisting aspiring IPTV operators

- Come to us for an open discussion without obligation

The $$$ opportunities are out there!
Topics

- Background
- IPTV/OTT Architectural Overview
- Business and Content Considerations
- IPTV/OTT Technology
  - Video Head-end
  - Ad Insertion
  - CAS / DRM Systems and Principles
  - Other IPTV/OTT System Components
- IPTV/OTT Total Solution Example
- Standards Bodies
- Summary
IP TV was first offered exclusively over managed networks
  - Control of Quality of Service (QoS) was essential
  - The Internet was too unreliable for broadcast quality TV

Over-the-Top (OTT) delivery was initially used to provide free (ad-based) content – television quality was not of importance
  - Stuttering, rebuffering, video artifacts, etc., were common

Major advances in streaming video technology since ~2010

Today, OTT services are offered in HD broadcast quality

The lower cost of OTT delivery is now impacting managed IPTV operators – Witness recent announcement by AT&T to switch from an IPTV to OTT model

The future will be all about Internet TV – and it is here now!
IPTV/OTT ARCHITECTURAL OVERVIEW

IPTV – Internet Protocol Television
OTT – Over-the-Top, a.k.a. Internet TV
An IPTV/OTT end-to-end (e2e) system consists of:

- Video & Audio Programming Sources
- Video Head-end, sometimes Network Operations Center (NOC)
- Video Distribution Network(s)
- Receiving Devices
Video Service Types

Video Services can be of three types:

1. Linear (Broadcast) Services, for one-to-many distribution
   - Live services, e.g. sporting and music events, breaking news, etc.
   - Previously recorded content
   - Typically Satellite, Cable or Terrestrial (“one-way”) transmission
   - Multicasting on managed IPTV networks but not the Internet

2. Video-on-Demand (VOD) Services, to individual users
   - Movies and TV shows
   - Any other content for which on-demand access can be justified
   - Almost exclusively through IP (two-way) networks via unicasting

3. Hybrid Services – the new wave
   - Broadcast and VOD services meet in a single receiver
   - Combines the best of both worlds, with more service diversity
   - Offer viewers a friction-less (transparent) experience
Video Head-end Sub-Systems

- Subscriber Management, Customer & Technical Support
- Content Ingest from various Programming Sources
- Video Processing – Content format preparation for delivery
- Asset Management and Playout Scheduling
- Middleware and/or Electronic Program Guide (EPG) Servers
- Ad Insertion
- If Pay-TV: Application of Content Security and Scrambling
  - Incl. Video Watermarking for Ultra HD Services, if applicable
- Content Output to Video Distribution Network(s)
  - Live Services Playout
  - On-demand Servers
- Video Service Monitoring and Quality Assurance
Typical Head-end Architecture

**Video Head-end**

- **Operator & Management Interface**
- **Accounting & Business Management**
- **Database**
- **Subscriber Management and Billing System**
- **Middleware**
- **CAS/DRM Servers HLS / DASH and Others**
- **Ad Insertion**
- **Monitoring**
- **Asset Mgmt & Playout Scheduling**

**Linear Content Ingest**

- **Key Requests & control data**

**Video Processing Linear Content Incl. AES-128 Encryption**

**Key Requests & control data**

**Media Servers Incl. AES-128 Encryption**

- **On-demand Content Ingest**

**Delivery Networks**

- **RF Broadcast Network**
- **Managed IP Network**
- **Internet/Broadband/CDN**
- **Mobile 3G/4G/LGE**

**Consumer Receivers**
Private Head-end or Outsourced?

New operators face an important choice

- Acquire and operate a private video head-end?
  - Advantage: Full control of all technical and operational aspects, and dedicated staff
  - Disadvantage: CAPEX to acquire and OPEX to operate

- Outsource head-end to “cloud” operator?
  - Advantage: Limited start-up costs and short time-to-market
  - Disadvantage: Complete dependence on cloud operator equipment, performance, and staff

An owned-and-operated OTT head-end requires high bandwidth access to distribution networks, CDNs, etc.

- Contractual network performance via Service Level Agreements
- Akamai, Level 3, Limelight Networks, Tulix, etc.
Streaming Protocols

- Live video streaming, mostly referred as just streaming, is a complementary technology to traditional downloading

- Common Streaming Protocols
  - Real Time Streaming Protocol (RTSP)
  - Real Time Messaging Protocol (RTMP) – Adobe Flash
  - HTTP-based Adaptive Bitrate (ABR) Protocols, e.g. HLS, DASH
    - HTTP: The underlying comm’s protocol for the World Wide Web

- Three distinct uses:
  - RTSP: Common for IPTV services over managed networks
  - RTMP: On-demand and live media to Flash applications
  - ABR Protocols: Foundation of modern OTT video delivery

To learn more, download the complimentary Live Streaming Video Protocols: A Brief History
Adaptive Bitrate Protocol Principles

- **ABR streaming**: Encoding of a single source, high bitrate video into multiple bitrate streams (i.e. quality levels)
- Each stream is segmented into multi-second "chunks"
- Client device determines available bandwidth in real time, and chooses the stream with optimum quality accordingly
- The client media player can switch between the different streams (bitrates) depending on available resources
Two types of video distribution networks:

1. Managed Networks, for Managed IPTV services
2. “Unmanaged” Networks, for Over-the-Top (OTT) services

1. Managed Networks – Owned and Operated Networks
   - Controlled by same operator that offers the IPTV services
     - Typically telcos with large wireline networks
   - Enables control of Quality of Service (QoS), e.g. video bitrates
     - BUT: Costly, and limited by reach of owned and operated network

2. Unmanaged Networks – Third-party network operators
   - The Public Internet, via Internet Service Providers (ISPs)
   - Content Delivery Networks (CDNs)
   - Mobile / Cellular Networks
   - OTT operator has little control of QoS unless SLA in place
A description of common server types follows next →

To learn more, download the complimentary Introduction to CDN and VOD Principles
Typical Video Distribution Servers

- **Origin Server**
  - Very large capacity storage and repository of primary copy of all media assets, with content served downstream on request
  - Content metadata available to head-end middleware and EPG (Electronic Program Guide) servers for presentation to users
  - Content ingested from various sources: real-time encoders, studios and content aggregators, over various types of networks

- **Regional Cache Server**
  - Large capacity, distributed proxy caches in regional layer for delivering often-requested downstream content from cache
  - Content pulled reactively from the origin server in response to user requests, or proactively as determined by policy

- **Edge Streamer**
  - High-bandwidth caching devices deliver content to “last mile” delivery components with precise timing and user playback control
Connecting the DVEO Encoder/Transcoder directly to DVB and other RF network sources saves cost and rack space of separate IRDs, enabling cost-effective transcoding of multi-format, multi-channel IPTV/OTT services.

Content optionally encrypted using third-party DRM, and streamed into multiple IP video delivery networks.

Satellite & Terrestrial DVB/ATSC TV Sources → Gearbox IRD & Transcoder → Atlas Media CDN &/or Edge Servers → Any Device Anywhere Anytime

Key Servers/DRM (optional)
Consumer Receivers

- Consumer Receivers, a.k.a. Consumer Electronics (CE) Devices
  - Traditional TV plus IP Set-top Box (IP-STB)
  - Smart/Connected TVs and STBs
    - IP broadband connection (Ethernet)
  - Desktop Computers, Laptops, Notebooks
    - Windows OS, Mac OS, Chrome OS, Linux
  - Smart Phones and Tablets
    - Either iOS or Android OS, some Windows OS
  - USB Sticks
    - Integrated IP-STB functionality and EPG
    - E.g. Amazon FireStick, Google Chromecast, Roku
  - Home Media Gateways
    - Receives content from network and redistributes it to authorized devices, usually DLNA certified (see Standards)
Client Device Media Players

- The client device needs to be enabled for:
  - Streaming protocol used to deliver video services
  - CAS/DRM if pay-TV services are involved
  - Electronic Program Guide and Media Player
    - Provide easy content discovery and navigation
    - Play content, incl. trick-play functions: Start, Pause, Rewind, etc.

- Media Players can be single OS/protocol
  - Apple Quicktime as used with the HLS protocol in iOS devices

- Several cross-platform Media Players, providing multiple OS and streaming protocol support, such as
  - VisualOn
  - Nexstreaming
  - Squadeo
BUSINESS AND CONTENT CONSIDERATIONS
Two basic business models: Free or Paid Services
- Free-to-Air, mostly advertising based, or
- Pay-TV, requiring a subscription and payment for watching

Both may implement linear and/or on-demand service models
- Balance of Live vs. Stored content a key question per operator

FTA may require content scrambling to authenticated devices
- “Geo-blocking” or “Regional Blackout” to comply with content licensing agreements, per country or per region
  - Not possible to depend just on IP addresses – only device authentication can determine if a device is truly “bona fide”
- Therefore, CAS (ECM & EMM) functionality but no Billing

Pay-TV needs Middleware, CAS /DRM and Subscriber Management & Billing Systems – more complex, but a larger income potential
Service Models: Linear vs. On-Demand

- Typical linear and/or on-demand service models
  - Subscription to a set of linear channels/packages (“bouquets”)
    - Basic Digital
    - Movie Pack
    - Sports
    - Special Interest
  - Video-on-Demand (VOD) – Play back programs at will, often with typical playback functions such as Pause, Rewind, Stop
    - May not be able to Fast Forward to skip commercials
  - Subscription VOD: Fixed price “all-you-can-eat” VOD model, e.g. Netflix and Amazon Prime streaming
  - Pay-per-View: Access on event-by-event basis, live or VOD
  - Pay-per-Time: Purchase ‘x’ hours of a specific channel, and watch periodically at viewer discretion
DVR and Network DVR

- Digital Video Recording (DVR)
  - Enables “Prime Time on My Time”
  - Also referred to as Personal Video Recording (PVR)
  - TiVo has been the trailblazer since DVR concept inception

- Requires a CE device, like TiVo, or Network DVR (nDVR)
  - All major operators provide their own branded DVRs, or TiVo
  - nDVR still contested legally by most major programmers

- Many viewers use their DVR to record all content they plan to watch except major live events such as sports and the Oscars
  - Gone are the days of broadcaster controlled “appointment TV”

- The DVR, together with the DVD, enabled “binge watching”
  - Record whole season, then watch episodes in rapid succession
  - The M.O. of Netflix and Amazon with their original content
Additional Services

➢ Consumer convenience is now of paramount importance
  o Restart TV – Go back to the beginning of the program playing
    • May even include a whole week’s prior programming
  o Near VOD – Substitute for “real” VOD when latter not possible
    • Multiple copies of a program are broadcast at short time intervals
      (typically 10–20 minutes) providing convenience for viewers
  o Push VOD – Used to optimize limited streaming infrastructure
    • Pre-download popular content to PVRs, enabling VOD services
    • Not used widely given proliferation of broadband
    • Hard for operators to pick “most popular content”
  o Other service permutations possible
    • Trade off of available bandwidth vs. content delivery quality

➢ Other services not discussed in this document
  o Internet browsing; interactive services such as shopping, games
Content Types

➢ Content acquisition and licensing is key any video business
  o See Content Security for considerations

➢ Content types
  o Ranges from general to very narrow focus
  o Broadcast and cable networks
    • Broadcast networks such ABC, CBS, CW, FOX, NBC and PBS
    • Cable networks, e.g. A&E, AMC, Bravo, Discovery, Disney, Turner
    • Premium cable networks such as Cinemax, HBO, Showtime
  o Live Sports – the most valuable content in the world today
  o Ethnic content, such as Hispanic, Asian, African programming
  o Government and Community Channels
  o Special interest, e.g. Animals, Cars, Cooking, Fishing, History
  o Shopping Channels
  o Adult and erotic content
Content Licensing

Content can be licensed directly from the programmers, or through specialized content aggregators

- Using a content aggregator saves time and the issues of negotiating content licensing with each programmer
- Ethnic content can also be imported directly, especially if not available in the country that is the target of the new services

Content aggregators offer wholesale-retail distribution model

- White Label and other options
  - Content pass through without local head-end processing
  - Add local content, with our without scrambling
  - Manage subscribers locally or via wholesaler’s business systems
- Examples of aggregators and wholesalers
  - Vubiquity, CSI Digital, DISH PCO, thePlatform

Content Security a key issue for offering pay-TV services
Local Content – Key Differentiator

- Original content creation may be beyond the budgets of most new operators, but...

- ...content of local interest can be a profitable proposition
  - Live coverage of local events
  - News
  - School teams sports coverage
  - Neighborhood or other community centric coverage

- Local content can be picked up off-air
  - Re-broadcast consent may be required

- Local content can also be created by the operator
  - A camera or two, and an encoder/streamer to transmit the content to the head-end for processing and distribution
Local and Live Event Broadcasting

- Connecting the DVEO Encoder to a video source enables multi-rate and multi-format live broadcasting
- Content optionally encrypted using third-party DRM for protected playback and delivered via a CDN for scaling to thousands of subscribers
- Deliver error-free video to CDN and/or PDI over the Internet with DOZER ARQ, for multi-screen play-out
H.264/H.265 SD/HD encoder and stream replication appliance

Ultra-reliable Linux/Intel platform; 2500+ in use worldwide

GigE, SDI, HD-SDI, or HDMI inputs

Protocols: UDP, RTP, RTMP (Open Flash), HTTP, DLNA support

Supports HLS and MPEG-DASH

Supports logo insertion, text overlay, and SCTE 35 cue tone insertion

Optional built-in server supports 1000+ simultaneous ABR or RTMP users

Performs AES-128 encryption with Verimatrix® VCAS™ and other DRMs

Embedded Linux® OS

DOZER ARQ

SSH, SNMP, REST, SOAP

Slim 1 RU size

Datasheet
In the U.S., the Federal Communications Commission (FCC) regulates television services, among else.

Retransmission Consent:
- The Communications Act requires that a television station give its consent to a cable system or other multichannel video programming distributor (MVPD) to carry its broadcast signal. Television stations and cable systems, as well as satellite carriers, negotiate for this “retransmission consent” and money or other consideration is generally exchanged between the parties in these private negotiations. If the parties do not produce an agreement in time, they may decide to extend the existing agreement, which means they would continue to carry the stations during their negotiations. If they do not reach an agreement, then the cable system or other MVPD must stop offering the stations to their subscribers.

- To learn more about retransmission consent agreement and the associated must carry rules, go to the FCC website for a useful Q&A on cable carriage of broadcast stations:
If any type of “premium” content (no exact definition) is to be included, invariably the issue of “content protection” arises
- Payment for distributing and watching content will be required

Content rights holders (programmers and distributors) have very stringent requirements for content security
- Content security issues must be considered from the outset
- Often an afterthought, preventing timely launch of services

Technology required to prevent from “unauthorized viewing”
- Conditional Access System (CAS), incl. scrambling / encryption
- Digital Rights Management (DRM), with built-in business models

Charging viewers for watching the content will require:
- Customer Care & Billing System (CC&BS), and/or
- Subscriber Management System (SMS)
IPTV/OTT TECHNOLOGY
VIDEO HEAD-END
The following steps are part of the Camera-to-TV processing:

- **Video Digitization**
  - IP video systems create or receive digitized video signals

- **Video Compression**
  - Compress the digital video, using MPEG-2 or H.264/AVC standards

- **Packet Transmission**
  - Packetize the video, add destination and control information to each packet, and manage the transfer through a data network

- **Packet Sequencing**
  - Receive and re-sequence the data packets into correct order

- **Video Rendering**
  - Convert the data packets into a form for viewing by people

Audio follows a similar sequence

Relevant standards are listed at the end of this document
Video Head-end Components

- Typical head-end equipment includes:
  - Content ingest equipment such as Professional Receivers/IRDs
  - Video and Audio Encoders and Transcoders
    - Preparation of content for output to video distribution network
    - Analog-to-digital conversion, compression, bitrate manipulation
  - Streamers and Media Servers for content play-out
    - Multicasting (one-to-many); Unicasting (individual service)
    - Time shifting (delayed play-out of content)
  - Ad Insertion Servers
  - Conditional Access (CAS) & Digital Rights Management (DRM)
  - Middleware Servers for Program Guides and Interactive Services
  - Subscriber Management, Traffic and Billing Systems

- More details will be provided later in this document
Video Head-end – Content Types

- Live/linear content for immediate re-broadcasting (below, left)
- Live/linear content to local storage; time-shifted playout
- File based content for immediate play-out
- File based content for local storage; scheduled play-out (right)
Video Head-end – Content Ingest

Video Programming Sources and Interface Standards:

- Gigabit Fiber via CDN or direct - IP
  - UDP, RTMP, RTSP, FTP
- Satellite – dish farm at head-end
  - DVB-S, DVB-S2
- Cable
  - DVB-C, DVB-C2
- Terrestrial – over-the-air antennas
  - 8VSB, DVB-T, DVB-T2, ISDB-T
- Live Camera in studio or remote location
  - SDI, HD-SDI; IP
- DVD Player
  - HDMI
Ingested content typically requires processing to adjust it to the output network characteristics, for example:

- Decryption of incoming signals to clear content state
- Analog-to-digital conversion
- Video and Audio compression, using MPEG-2 or H.264/AVC
- Transcoding – bitrate conversion
- Upscaling SD-to-HD or downscaling HD-to-SD
- Add protocol wrappers, e.g. adaptive bitrate protocols (HSL, DASH)
- Content scrambling

Processing often requires racks of expensive equipment

- Professional Receivers/IRDs
- Encoders, Transcoders, Streamers and Media Servers
- CAS/DRM Encryption

The DVEO Gearbox combines many of those functions (next)
Broadcast quality, multi-channel transcoder, 0.1 to 15 Mbps
- Inputs: Mix of (HD-)SDI, DVB-S/S2, DVB-C, DVB-T/T2, DVB-ASI, 8VSB, QAM (digital or analog), ISDB-Tb, DTMB, Analog (CVBS), or GigE and IP (H.264, MPEG-2, or VC-1); Compact 3 RU size
- IP out: SD/HD MPEG-2, H.264/AVC, H.265/HEVC, VC1
- Protocols: UDP, RTP, RTMP (Open Flash), HTTP, DLNA support
- Supports HLS and MPEG-DASH
- Optional built-in server supports 1000+ simultaneous ABR or RTMP users
- AES-128 encryption
- Embedded Linux® OS
- DOZER ARQ
- SSH, SNMP, REST, SOAP
- **Datasheet**
Packaging Server

- Powerful Live and On-demand Server for IPTV/OTT, CDN, ISP, Hospitality
- Live grooming with packaging on the edge, on the fly, and on demand
- Ingests H.264, H.265 live streams (IP); HD & SD, H.265/HEVC & H.264/AVC
- Ingests MPEG-2 TS and H.264 files for VOD playback
- Output: HTTP Live Streaming (HLS), MPEG-DASH, RTMP, MPEG-TS
- Supports Catch-up TV and Live Timeshift (Rewind/Fast Forward) over HLS
- Inserts pre-encoded ads based on schedule or with SCTE markers
- Performs AES-128 encryption w/Verimatrix® VCAS™ and other DRMs
- 3 sizes, scaling to tens of thousands of simultaneous users
- Linux OS
- DOZER ARQ
- SSH, SNMP
- REST & SOAP SDK
- Datasheet
Key Encoder/Transcoder Requirements

- Real-time H.264/AVC encoding and transcoding, SD and HD
- Commercial grade HW platform and OS; dual power supplies
- Encode streams with multiple resolutions at .1 to 15 Mbps at popular GOP sizes, frame rates, refresh rates, or aspect ratios
- Transcode on-the-fly MPEG-2 to H.264 or H.265
- Simultaneously create high, medium, and low bitrate adaptive bitrate (ABR) streams to hand off to CDNs or ISPs
- Support industry standard protocols like UDP or RTP and “wrappers” such as HLS, DASH, Smooth Streaming, RTMP, etc.
- Multiple audio protocols, Closed Captioning and Teletext
- Remote Management via SNMP
- The DVEO Brutus fulfills or exceeds above requirements (next)
Optimized ABR Transcoder

- Enterprise class, up to 200 Ch. H.264/H.265 SD/HD Adaptive Bit Rate Optimized Transcoder for multiscreen IPTV/OTT
- Ideal for IPTV/OTT/ISP/CDN multi-bitrate stream replication
- Protocols: UDP, RTP, RTMP (Open Flash), HTTP, DLNA support
- Supports HLS and MPEG-DASH
- Optional built-in server supports 1000+ simultaneous ABR or RTMP users
- Performs AES-128 encryption with Verimatrix® VCAS™ and other DRMs
- Embedded Linux® OS
- DOZER ARQ
- SSH, SNMP, REST, SOAP
- 6 models: Brutus I-VI
- Datasheet

www.dveo.com

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Infinity IP Server™ – “IPTV in a Box”

- Plays 50 IP “web channels” continuously or using preset schedule via built-in scheduler and remote GUI
- Great for OTT operators, ISPs, Hospitality and Digital Signage
- Input: FTP file transfer; optional on-the-fly transcoding
- IP out: Multicast/unicast TS UDP, RTP, RTMP (Open Flash), HTTP, with DLNA support, in any video resolution
- Performs AES-128 encryption w/ Verimatrix® VCAS™ and other DRMs
- Embedded Linux® OS
- 2 TB storage
- SSH, SNMP, REST, SOAP
- Slim 1 RU
- [Datasheet](#)
Professional IRDs, a.k.a. Integrated Receiver Decoder (IRD)
- Demodulation, decryption, decoding of incoming signals
- Digital or analog output
- Monitoring and Quality Assurance (QA) of outgoing video

A related category is Monitoring & Transport Stream Analysis
- Verify quality of video services as output to delivery network
- Multi-window Transport Stream monitoring
- Detection and logging of anomalies such as video freezes, black screens, loss of video, audio, or subtitles
- Transport Stream recording
- Alarm generation

The DVEO Q-Check is the ideal complement to a state-of-the-art video head-end for managed IPTV or OTT services (next)
Real-time, scalable IP or ASI Transport Stream Analyzer with 24/7/365 monitoring and analysis for Head-Ends or Teleports

Multi-Window monitoring of digital video services, IP or ASI
Displays up to 65 MPEG-TS and analyzes up to 200 MPEG-TS
MPEG-2, H.264/AVC and H.265/HEVC TS Monitoring, Analysis, Error Logging with multiple Alarms, TS Recording
Detects and Logs Video Freezes, Black Screens, Loss of Video, Audio, or Subtitles (TR 101 290 priority level 1, 2 & 3 errors)
MPTS and SPTS, with DVB SI and ATSC PSIP table decoding
SNMP, email & audio alarms
System or Software License
Datasheet
AD INSERTION
As video services make their way from the point of origination to the viewers, there can be any number of reasons for the desire, or even an urgent need, to insert or overlay a program with other content that may be informational, e.g.:

- TV station or network logo
- Sports results
- Promotions for programs coming up
- Commercial advertising

Some of the content is inserted for revenue generation, mostly advertising as a means to monetize programming.

Some may be mandated by local government, such as emergency alerts in response to a natural catastrophe.
Ad Insertion Principles [2]

- Often remotely originating content carries ads that are either not relevant to the local viewers or have become outdated.
- Creates monetization opportunities by offering ad spots for local businesses.
  - Changes the value proposition of the program by enabling insertion of ads that carry local relevance.
- Ads come in many forms, like the 30-second commercial that is “spliced” into the video stream.
- Often a requirement not to interrupt the program by instead overlaying graphics semi-transparently.
  - Positioned around video, static/blinking.
  - Top, bottom, L-shaped wrap around, etc.
  - Tickers, text, sports results, station logo.
Dynamic and Targeted Ad Insertion

- **Static Ad Insertion:** Ads are inserted in advance and cannot be replaced by the TV operator once the content is transmitted.

- **Dynamic Ad Insertion:** Operators can provide targeted ads that can be inserted as the content is delivered to the viewer.
  - Opportunistic ad insertion, combining e.g. content type, viewer profile, and geolocation data.
  - DVEO offers solutions for both broadcast and IPTV.

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Satellite & Terrestrial TV Program Sources

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Content  Gender  Age
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<tr>
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<tbody>
<tr>
<td>Location</td>
<td>Income Level</td>
<td>Spending Patterns</td>
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Dynamic Ad Insertion
Inserts or overlays graphics, video clips, logos, CG, scrolling text, and emergency alerts into live and stored video feeds on a schedule or via signaling like SCTE-35; HD or SD

Static, rotating, flipping, or blinking graphics, logos, and text

Drag-and-drop, scheduled play-out or via Cue Tones (SCTE-35)

IP, ASI or SDI/HD-SDI inputs/outputs, MPEG-2 or H.264

Inserts content in 1-20 IPTV, cable TV or on-air TV channels

Datasheet
Targeted, dynamic multi-criteria, multi-stream HLS Ad Inserter

Combines content type, consumer profile, and geolocation data by "mining" multiple data bases in real-time

Ads inserted inside, overlaid or around video content via slices, overlays, text crawls, alert bugs, and video squeezes

Ads initiated via various mechanisms, e.g. SCTE-35, Contact Closure, IP messaging, scheduled or manual triggering

The AD SPOTTER consists of three components – Datasheet

- **SPOT 35**: Transcodes content and inserts SCTE-35 with metadata required for Ad Insertion
- **SPOT Server**: Interprets SCTE-35 commands and prepares live streaming with multiple ad combinations
- **SPOT Server**: Serves user targeted streams to viewers
CONTENT SECURITY SYSTEMS AND PRINCIPLES
Definition of Content Protection

- Content Protection is the process of securely determining if a particular viewer shall be granted access to specific content, e.g. a video/audio channel or an on-demand movie
  - Geo-Blocking – Restricting access based on user’s location
  - CAS – Conditional Access System
    - Transport content protection: Satellite, Cable, Terrestrial, IPTV
    - Required in order to license ANY premium pay-TV content
    - Simulcrypt standard ensures interoperability MUX-CAS
  - DRM – Digital Rights Management
    - Persistent content protection incl. storage; survives transport
    - Used for IP based video, in both IPTV and OTT applications
    - Limited standardization and interoperability

- Distinctions CAS-DRM often blurred, especially for IPTV/OTT
Geo-Blocking

- Exclusive territorial rights to content may differ between regions, requiring service providers to disallow access for users outside of their designated region.

- Geo-blocking is a basic technique to ensure that content cannot be viewed in geographies other than where authorized:
  - The user's location is calculated using geolocation techniques, such as checking the user's IP address against a list.
  - Controls access to premium multimedia content on the Internet.

- However, geo-blocking can be fairly easily circumvented:
  - When IP address-based geo-blocking is employed, VPN and anonymizer services are often used to evade geo-blocks such as those erected by online video services.

- Much stronger CAS/DRM techniques required for pay-TV.
CAS/DRM – Essential Functions

- Encryption of Content – Two widely used Algorithms
  - DVB-CSA (Common Scrambling Algorithm) in DVB CA systems
  - AES-128 Encryption for IPTV and OTT CAS/DRM systems

- Key Management: Manage the secret keys used to encrypt the content, as well as user specific “digital rights” keys
  - Entitlement Management: Provide “channel lineups” to each STB that reflects a subscription; access to Pay-per-View events
  - Transmitted in Entitlement Management Messages (EMM)

- Device Authentication: Only those devices recognized by the CAS/DRM will be issued with Keys to decrypt the content

- Business Rules: For content recorded to a DVR or downloaded to a tablet or computer, how long may it remain there? May it be viewed offline? May it be copied to other devices? Etc.
The DVEO range of encoders/streamers/transcoders and media servers can all perform AES-128 Encryption.

The same DVEO products are integrated with:
- Verimatrix® VCAS™
- Microsoft® PlayReady DRM, with more in the pipeline

The diagrams on the next two pages illustrate:
- Verimatrix VCAS for Internet TV (OTT) and VCAS for IPTV (managed networks), protecting keys and content through:
  - Key Management for encryption and user entitlements
  - Device Authentication to ensure only bone fide receivers can receive keys from VCAS
- DVEO MultiStreamer, a telco grade encoder and streamer
- DVEO Atlas Media Server, thousands of simultaneous HLS users, performs AES-128 Encryption in conjunction with VCAS
DVEO-Verimatrix Architecture – OTT

Verimatrix VCAS for Internet TV

- Verimatrix OMI: Entitlement Cache
- Verimatrix MultiCAS Adaptive
- Verimatrix Adaptive CSM (Keys)

Device Authentication and Entitlement
Key Data

Program ID & Keyfile Exchange

Client Authentication and Keyfile Requests

Internet and/or CDN

IP Transport Streams
MPEG-2 or H.264

Brutus V: Demultiplexing, Encoding & Transcoding

DVEO Encoding & Streaming

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Verimatrix Adaptive CSM (Keys)

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Client Authentication and Keyfile Requests

Internet and/or CDN

AES-128 Encrypted Streams

Playlist File (.m3u8) & Encrypted Media Chunks

IP Transport Streams

MPEG-2 or H.264

DVEO Encoding & Streaming

Brutus V: Demultiplexing, Encoding & Transcoding


Billing, Subscriber Management, &/or Middleware

DVEO-Verimatrix Architecture – IPTV
CAS – Simulcrypt [1]

- Simulcrypt, originating from DVB, is a MUX-CAS interface
- It governs key exchanges as follows:
  - The MUX Simulcrypt Synchronizer generates content scrambling keys (Control Words) using a random number generator
  - The key is passed to each connected CAS
  - Each CAS wraps the key into an ECM and returns it to the MUX
    - ECM = Entitlement Control Message
  - The MUX inserts the ECM(s) into the MPEG Transport Stream
  - The MUX scrambles the content using the same key
  - Keys are changed and transmitted every 10 seconds or so
- Each STB receives the ECM and uses a master key to decrypt it
- It then uses the key from the ECM to descramble the content
- The content is displayed on the TV or other display device
All CA and DRM systems are proprietary by their nature
  - However, certain messaging mechanisms are common

The DVB Simulcrypt standard was a major breakthrough
  - Simulcrypt enables several CA systems to share a head-end
    - Simulcrypt defines how a CAS interfaces to the MUX
    - There is no interfacing required between CA systems
  - The video streams are shared, thus saving valuable bandwidth
  - Each STB belongs to one CA only and recognizes its ECMs

Today Simulcrypt is used among DVB and IPTV systems
  - Its use beyond DVB has been a global enabler of interoperability

DVEO supports Simulcrypt in addition to the DRM key exchange interfaces as used by e.g. Verimatrix
Video Watermarking

- A technique to perform limited pixel modification for the purpose of carrying data in the video
- Invisible, yet powerful tool to bind data to video:
  - Date & Time, Channel or Content ID, Service Operator
  - Subscriber ID or STB ID
  - Uniquely identifies the “last authorized recipient” of content
- Not to be confused with “fingerprinting” or “onscreen bug”
- Watermarks survive decoding to analog, and various types of video transformations incl. re-encoding
- Watermarked video requires special decoder to retrieve data
- Required for Ultra HD Services per MovieLabs specification
- Tool for legal enforcement in case content is misappropriated
Watermarking in the Value Chain

Options on Performance, Uniqueness and Application

Source: Ultra HD Forum CES ’16 Meeting
CAS and DRM Vendors

- Major CA system vendors (in alphabetical order):
  - Irdeto (part of Naspers, South Africa)
  - Nagra (incl. Conax)
  - NDS (part of Cisco)
  - Verimatrix (independent)
  - Viacess (part of France Telecom)

- Major DRM provides:
  - Above CA vendors generally provide DRM solutions too
  - Adobe (PrimeTime)
  - Apple (Fairplay)
  - Google (Widevine)
  - Microsoft (PlayReady)

- There are many smaller vendors in each category
OTHER IPTV/OTT SYSTEM COMPONENTS
DelayServer IP™

- Multichannel TS or HLS Time Delay Server
- Ideal for Time Shifting 40+ IPTV/OTT streams for up to 8 hours
- Multi-protocol IP in/out, SD/HD, MPEG-2/H.264, uni/multicast
- Intel® High-end SSD (0.25 TB and up) in lieu of bulky RAIDs
- Embedded Linux® OS
- DOZER ARQ
- SSH, SNMP, REST, SOAP
- Slim 1 RU
- Datasheet
D-Streamer IP/DIG™ A/V Decoder

- HD and SD H.264/AVC, MPEG-2 or H.265/HEVC decoding
- Input: Bursty or smooth IP (H.264, MPEG-2, or H.265)
  - Protocols: HTTP Live (HLS), UDP, RTP, RTMP (from Flash server), HTTP; unicast or multicast
- Audio: AAC, Ogg Vorbis, MPEG-1 Layer II, and pass through
- Output: SDI and HD-SDI; optional HDMI output
- Configure and operate via Remote GUI
- Embedded Linux® OS
- DOZER ARQ
- SSH, SNMP, REST, SOAP
- Slim 1 RU size
- Datasheet
The SMS is the core of a Customer Care system and stores all subscriber data, e.g. name, contact and payment information.

- It also holds the subscriptions that the viewer is entitled to, which may include channels, on-demand content, DVR support, and any other authorized devices.
- May require a Call Center unless outsourced.
- Consider Technical Support requirements for subscribers too.

If a subscriber has multiple devices (whether at home or in different locations), it is referred to as a subscriber domain.

- A domain is the basis for TV Everywhere services; a user can start watching on one device and then continue on another.

The SMS may include Billing functionality too – if not a separate Billing System is required, or it may be outsourced.
Middleware controls the User Interface and other functions
Advanced MW can also perform subscriber management and related business management functions
A head-end MW Server communicates with MW Clients
Trend is towards more asymmetrical client-server functionality
  - More processing in the head-end, less in the client
MW can be an expensive proposition; some STB vendors offer built-in, limited MW functionality that may serve well initially
It is not uncommon that operators with inhouse SW staff develop own MW – or even Apps – to suit their specific needs
Apps increasingly common as low-cost substitute
  - For example, in Roku STBs and in Connected/Smart TVs
IP Set-top Boxes and Other Receivers

- There are literally hundreds of IP-STB makers and thousands of models to choose from, especially from China and Korea
  - Some are well known brands such as Roku and Amino
- PCs running Windows or Mac OS are also popular
  - Preference is shifting toward mobile devices
- DRM fragmentation across devices is problematic
  - Silo-based, proprietary DRM systems
  - PlayReady DRM for Windows but Chrome requires Google DRM
  - Apple Fairplay for iOS devices
  - Some security vendors offer multi-DRM support, e.g. Verimatrix
- Also the issue of different streaming protocols
- Managing multiple DRMs and protocols is a big challenge
  - Deserves careful consideration in the planning stage
IPTV/OTT TOTAL SOLUTION EXAMPLES
The next page details a complete and versatile e2e solution for IPTV and OTT service delivery.

From left-to-right it illustrates:

- **Content Acquisition and Ingest**
  - File-based content
  - Live content from Satellite and Off-air broadcasting
  - Live local content captured via camera(s)

- **Content Aggregation and Head-end Processing**
  - Transcoding
  - Real-time video delivery with automated UDP packet recovery
  - Content security (CA/DRM)
  - Transport stream analysis and monitoring

- **Multi-network Distribution and Multi-screen Delivery**

- **Presentation and Consumption on various CE devices**
Hospitality/Campus Total Solution

Master Head-end

DISH Smartbox™

DVEO Brutus VI ABR Transcoders (2:1 Redundant)

DVEO IP/ASI Mux (1:1 Redundant)

DVB-S Satellite Modulators (1:1 Redundant)

Campus Head-end

Private Satellite

Decrypt via Simulcrypt & Re-encrypt w/Verimatrix

Verimatrix® VCAS™ (CAS/DRM)

DVEO Gearbox 2 IRD & Transcoders (1:1 Redundant)

DVEO Atlas 3 Edge Media Servers (1:1 Redundant)

Satellite & Off-air Content

UPTIME

UPTIME

Satellite + Local Content

Consumers

DVB-S

ATSC

Satellite + Off-air Content

DVEO Gearbox 2 IRD & Transcoders (1:1 Redundant)

DVEO Atlas 3 Edge Media Servers (1:1 Redundant)

Client Devices with Verimatrix ViewRight® Clients

DISH Smartbox™

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Satellite & Off-air Content

Satellite + Local Content

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Verimatrix® VCAS™ (CAS/DRM)

Satellite & Off-air Content

Satellite + Local Content

Client Devices with Verimatrix ViewRight® Clients
ENCODERS, TRANSCODERS AND STREAMERS
DVEO Main Product Lines [1]

- **Encoders, Transcoders and Streamers**
  - iCandy™ 4K UHD H.264/H.265 live 4:2:0 hybrid contribution encoder
  - MultiStreamer™ DIG/IP – H.264/H.265 encoder and IP/ABR streamers
  - Gearbox™ IP/IP – Broadcast quality, multi-channel transcoders
  - Brutus™ IP/IP – Adaptive optimized transcoder/re-streamers
  - Encoders/transcoders feature DOZER ARQ automated packet recovery

- **Media Servers**
  - Atlas Media Server™ – Multichannel grooming, Live & VOD services
  - Delay Server IP™ – Multichannel delay for time shifting
  - Infinity IP Server™ – “IPTV in a box” 50-channel play-out
  - Mavio™ 4K UHD H.264/H.265 Video Server

- **Error-free Real-time Video Delivery over IP**
  - DOZER™ ARQ – Automated packet recovery for smooth live video
DVEO Encoder Family

➢ All-in-One Appliances
  o Encoder & Transcode → Encrypt → Multi-Stream → Multi-Screen
  o MPEG-2, H.264/AVC, H.265/HEVC
  o Budget friendly and scalable from 2 to 200 channels
  o APIs for easy integration, control, monitoring, and content security

➢ Practical Appliance Solutions for Any Content Needs
  o Packetize content for all delivery methods (UDP, RTP, HLS, DASH, RTMP)
  o Protect content using studio approved DRM such as Verimatrix®

➢ Any Input Source to Any Output Type
  o IP, SDI, HD-SDI, HDMI, DVB-S/S2, DVB-T/T2, DVB-C, ATSC, ISDB-Tb, Composite
DVEO Encoder Family – Models

- All products H.264/H.265 capable
  - All produce multi-protocol and multi-bit rate IP video outputs: HLS, DASH, etc.
- Event Broadcasting
  - MultiStreamer DIG/IP: TELCO, 5-20 channels
  - Input: 2 x HD-SDI or 1 x HDMI
- High Density Connectivity
  - Gearbox and Gearbox II, 40-80 channels
  - Input: 12 x HD-SDI or 12 x DVB/RF
- High Density IP Ingest
  - Brutus V & VI, 160-200 channels
  - Up to 30 x 1080p ingest feeds
One Encoder – Multiple Destinations

- Create, packetize, encrypt, and aggregate source content
- Delivery to CDN, private delivery infrastructure (PDI) and direct-to-device playback, simultaneously

DVEO Encoder Family
- Multi-Protocol Segmentation
- Remote Management
- Multi-DRM
- Direct-to-CDN and Direct-to-Cloud
- Evolves with Standards
One Encoder – Multiple Sources

- Ingests multiple sources in multiple formats, saving cost and rack space by not requiring separate IRDs
- Encodes/transcodes to single and multi-rate profiles
- Deliver error-free video to CDN and/or PDI over the Internet with DOZER ARQ, for multi-screen play-out

SDI/HD-SDI + HDMI

Live IP Source

IP + SDI Camera

MPEG-2 TS IP Ingest

Satellite

Terrestrial

DVB

ATSC/DVB

ARD & Transcoder

Gearbox

Atlas Media CDN/PDI &/or Edge Servers

Playback Content

A/V File Archive Content

Smartphone

Tablet

PC/Mac

Smart TV

www.dveo.com
A range of models that scales to a wide variety of requirements and budgets.

<table>
<thead>
<tr>
<th>Form Factor</th>
<th>MultiStreamer II™</th>
<th>Gearbox™</th>
<th>Gearbox II™</th>
<th>Brutus IV™</th>
<th>Brutus V™</th>
<th>Brutus VI™</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD 1080p</td>
<td>5</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>HD 720p</td>
<td>7</td>
<td>15</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td>SD 480p</td>
<td>20</td>
<td>40</td>
<td>80</td>
<td>120</td>
<td>160</td>
<td>200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. Output Channels</th>
<th>Click here</th>
<th>Click here</th>
<th>Click here</th>
<th>Click here</th>
<th>Click here</th>
<th>Click here</th>
</tr>
</thead>
</table>

DVEO Encoders/Transcoders and Streamers
No. of Output Channels per Given Resolution and Average Bitrate

- Brutus VI™
- Brutus V™
- Brutus IV™
- Gearbox II™
- Gearbox™
- MultiStreamer II™

[PDF Product Sheets](#)
 Delivers real-time video error-free over any IP network
 Patented DVEO ARQ automated packet recovery algorithms eliminate packet loss and re-orders out-of-sequence packets
 Enables live broadcasting over the public Internet using UDP
 Unicast/multicast MPEG-2, H.264/H.265 SPTS & MPTS over IP
 Replace costly managed networks or satellite backhaul
 Three versions, in DVEO-provided hardware or SW SDK
  o DOZERbox; DOZER Racks 1 RU; DOZER ARQ:LIC SW License
 Point-to-Multipoint
 Embedded Linux OS
 AES-128, SNMP, SSH
 **Datasheet**
Example: Live Multi-CDN Distribution

DVEO Encoder Family
✓ Multi-Protocol Segmentation
✓ UDP with DOZER ARQ
✓ Remote Management
✓ Multi-DRM Integrations
✓ Direct-to-CDN and Direct-to-Cloud
✓ Linux OS on Intel Platforms for 24/7/365
✓ Evolves with Industry Standards

www.dveo.com

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Scaling and Future Proofing

Scaling Incrementally
- Start small, grow incrementally with increase in subscribers
- Use modular platform, e.g. DVEO Encoder/Transcoder Family
- Add media server capacity as required, e.g. DVEO Atlas Servers

DVEO – Future Proofing Built In
- Intel® HW platform – Xeon® MultiCore processors
  - Scaling to any deployment size and performance requirement
  - Intel constantly improving price/performance
- Open source Linux® based software
  - DVEO enhanced libraries for outstanding reliability and throughput
- Support for formal industry and *de facto* industry standards
  - Streaming protocols: HLS, MPEG-DASH, RTMP and more
  - Codecs: MPEG-2, H.264/AVC and H.265/HEVC
  - Standards: SDI, HD-SDI, ASI, DVB, ATSC, SCTE, SMPTE, etc.
Many considerations before deciding to launch IPTV business

- IPTV or OTT?
- Business model – Live only, or Live and VOD? Free or pay-TV?
- Own head-end or cloud-based service via third-party?
- Content – what type? Licensing conditions?
  - License directly, or through a content aggregator?
- Vendor selections – may apply also for cloud-based services
  - Subscriber Management & Billing System – unless outsourced
  - Encoder/Transcoders and Streamers, Media Servers
  - Middleware, Ad Insertion, CAS/DRM, QA Monitoring, etc.

DVEO stands ready to assist in any way we can

- Total solution approach: System design, dimensioning and equipment selection including third-party vendors
- Installation and Training; ongoing support once service is live
Why DVEO

- Affordable solutions for managed IPTV and OTT providers
  - Reduces CAPEX and OPEX, and hence ultimately lowers TCO
- Consistent APIs for Control, Billing, Subscriber Management, Reporting, Monitoring, and Content Security/DRM
- Combine with Atlas Media Servers for scalable deployments
- Ultra-reliable 24/7/365 platform: Linox OS on Intel hardware
- The platform evolves with advancements in technology:
  - ASI → IP; MPEG-2 → H.264/AVC → H.265/HEVC; Flash → HLS/DASH
Focused on broadcast and telecoms industry

- Sales Channels
  - Direct sales
  - Private Label/OEM
  - Resellers
  - Offering products that do not compete with our channel partners

DVEO Today – 2016

- Strong supplier to broadcasters, cable, satellite, IPTV & OTT operators globally with well-priced technology and client-first customer care
- Leader in Linux® based Video Encoding, Transcoding, Grooming and Streaming, Ad Insertion, Transport Stream Analysis, niche Test Equipment
- Patented IP video smoothing via UDP ARQ Automated Packet Recovery
- Winner of SBE Technology Award 2014 with DOZER IP/IP™
Strength from Within – Here to Stay

➢ **Firm Financial Foundation**
  ○ Privately held and self funded
    • No outside investors or financial partners; no debt
  ○ Profitable since inception

➢ **Talented Team**
  ○ 4 Teams with Graduate Degrees
    • 20 staff: 14 in San Diego + offices in Florida, Princeton NJ and Boston MA

➢ **Blue Chip Customer Base**
  ○ Broadcasters, manufacturers, and systems integrators, e.g.:
    • ABC, CBS, Fox, NBC, PBS, Sinclair Broadcast Group, Time Warner
    • Arris, Cisco, Harmonic, Intel, Lightsquared, Sony
  ○ IPTV and OTT operators across USA, Europe, Middle East

➢ **DVCare™ Extended Warranty & Customer Care Plans**
  ○ Peace of mind and Priority Support
Standards Bodies [I]

- **MPEG, [www.mpeg.org](http://www.mpeg.org)**
  - **Moving Picture Experts Group** is the name of a family of standards used for coding audio-visual information (e.g., movies, video, music) in a digital compressed format.

- **MPEG, [mpeg.chiariglione.org](http://mpeg.chiariglione.org)**
  - MPEG, a working group of ISO/IEC with the mission to develop standards for coded representation of digital audio and video and related data. In its 25 years of activity MPEG has developed an impressive portfolio of standards and technologies that have created an industry worth several hundreds billion USD.
  - There are many useful tutorials accessible from the above page.

- **ITU, [www.itu.int](http://www.itu.int)**
  - An organization based on public-private partnership since its inception, ITU currently has a membership of 193 countries and almost 800 private-sector entities and academic institutions.
Standards Bodies [II]

- DASH-IF, dashif.org
  - The DASH Industry Forum creates interoperability guidelines on the usage of the MPEG-DASH streaming standard, promotes and catalyze the adoption of MPEG-DASH and help transition it from a specification into a real business

- DLNA, www.dlna.org
  - The Digital Living Network Alliance is a technology standards organization driven to build industry consensus to advance the interoperability of products in consumers’ connected homes. Founded in 2003 with a current membership of more than 150 companies, this unique multi-industry collaboration continues to implement an innovative set of guidelines utilized by service providers, electronics manufacturers, and software developers to provide consistent performance in the connected home.
Standards Bodies [III]

- **HbbTV, hbbtv.org**
  
  **Hybrid Broadcast Broadband TV** is both an industry standard (ETSI TS 102 796) and promotional initiative for hybrid digital TV to harmonise the broadcast, IPTV, and broadband delivery of entertainment to the end consumer through smart TVs and STBs. The HbbTV consortium, regrouping digital broadcasting and Internet industry companies, is establishing a standard for the delivery of broadcast TV and broadband TV to the home, through a single user interface, creating an open platform as an alternative to proprietary technologies.

- **DVB, www.dvb.org**
  
  The **Digital Video Broadcasting** Project is an industry-led consortium of over 200 broadcasters, manufacturers, network operators, software developers and regulators from around the world committed to designing open technical standards for the delivery of digital television.
Thank You!

Computer Modules, Inc.
DVEO Division
11409 West Bernardo Court
San Diego, CA 92127, USA
Telephone: +1 858 613 1818
Fax: +1 858 613 1815
www.dveo.com