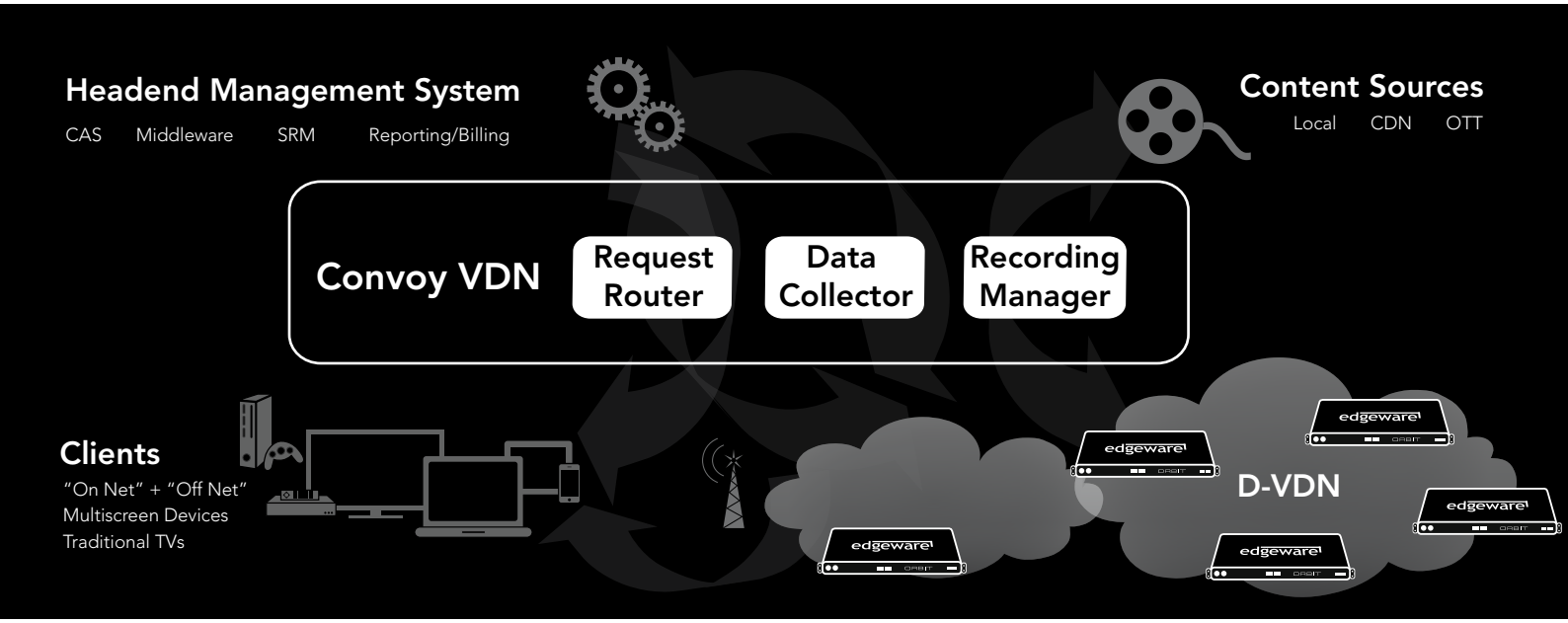


Convoy VDN System

CONVOY VDN (VIDEO DELIVERY NETWORK) SYSTEM PROVIDES ONE OF THE TWO MAIN ELEMENTS TO EDGEWARE'S DISTRIBUTED VIDEO DELIVERY NETWORK ARCHITECTURE. CONVOY VDN ALLOWS AN OPERATOR TO MANAGE A RETAIL BASED VIDEO DELIVERY NETWORK ACROSS ANY NETWORK TOPOLOGY, PROVIDE ADVANCED VIDEO SERVICES SUCH AS NPVR AND ALSO TO OFFER A WHOLESALE VIDEO DELIVERY CAPABILITY TO CONTENT PROVIDERS.

Key Features:

- Distributed content propagation, load balancing and fail-over – Robust and highly scalable system design
- Efficient use of network resources through fully automated popularity based content propagation
- Integration of wholesale CDN management and video delivery systems allows analysis and management of video stream quality in complex HTTP adaptive streaming environments
- Distributed Edgeware servers provide pre-processed log and statistics information for efficient and highly scalable reporting
- Session setup through stateless request router, allows for easy scalability and high availability operation through the use of multiple servers
- Integration with third-party content management systems and business intelligence systems through powerful APIs
- Support for nPVR and time shift TV services through Account API

Key Benefits:

- Ability to upgrade existing Edgeware installations
- Lower priced Basic Version for a single content provider i.e. service provider's own multi-screen service
- Multi-service Advanced Version for a full wholesale CDN
- Combined Web/IPTV operation
- Highly distributed architecture resulting in a small management server overhead – Edgeware delivery servers manage:
  - Statistics aggregation
  - Load balancing
  - Popularity measurements
- nPVR / Catch-up TV Option for all HTTP adaptive protocols and IPTV multicast streams
- In-depth realtime and historic analytics including
  - Quality profiles
  - Engagement per asset
  - Network utilisation

Key Distributed Video Delivery Network (D-VDN) Elements

Edgeware's D-VDN framework is made up of several elements:

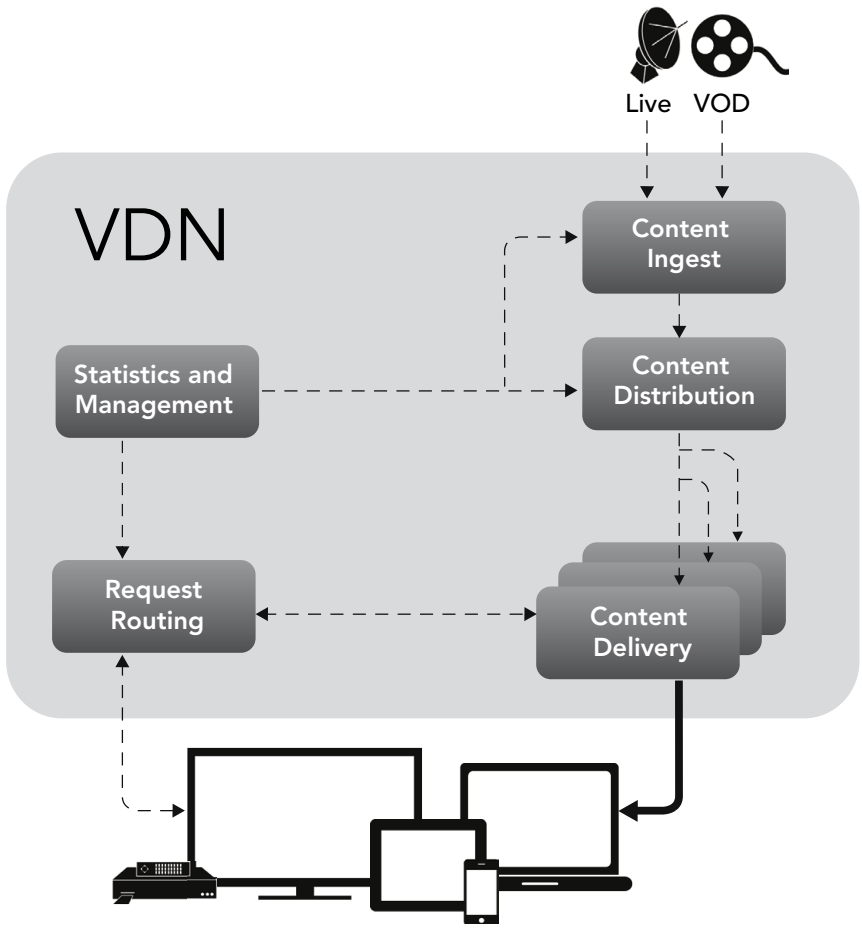
Convoy Video Delivery Network (VDN) System
– tightly integrates core functions with the Central and Edge Streaming Servers to provide complete management of a Distributed Video Delivery Network. Supports both web streaming protocols and traditional IPTV streaming in a single managed network.

Streaming Central and Edge Servers
– Edgeware WTV and Orbit servers providing the streaming services to client devices as well as content caching and recording.

Origin Servers
- Redundant origin servers for each proprietary HTTP adaptive streaming protocol to be delivered i.e. Microsoft IIS and Adobe FMS servers.
- For open HTTP adaptive streaming protocols and progressive download a HTTP capable NAS can be used as origin

NAS Storage – Centralized, redundant NAS systems for storage of VOD files, time-shift TV and nPVR recordings. Any NAS that supports FTP/HTTP and NFS/CIFS can be used, given appropriate dimensioning of storage and bandwidth performance.

Figure 1 – *Convoy VDN Functional Blocks*



Convoy VDN Functional Overview

Content Ingest
VOD content is ingested onto the VDN via API. Live content is distributed to publishing points. The Convoy VDN Management system configures the publishing points with the allocated storage quota and provider publishing credentials.

Content distribution
Content handled by the VDN is distributed to the different Origin Servers and the Central / Edge Streaming Servers and NAS Storage such that a good balance is maintained between server load, server storage usage, VDN fault tolerance and core versus edge network bandwidth.

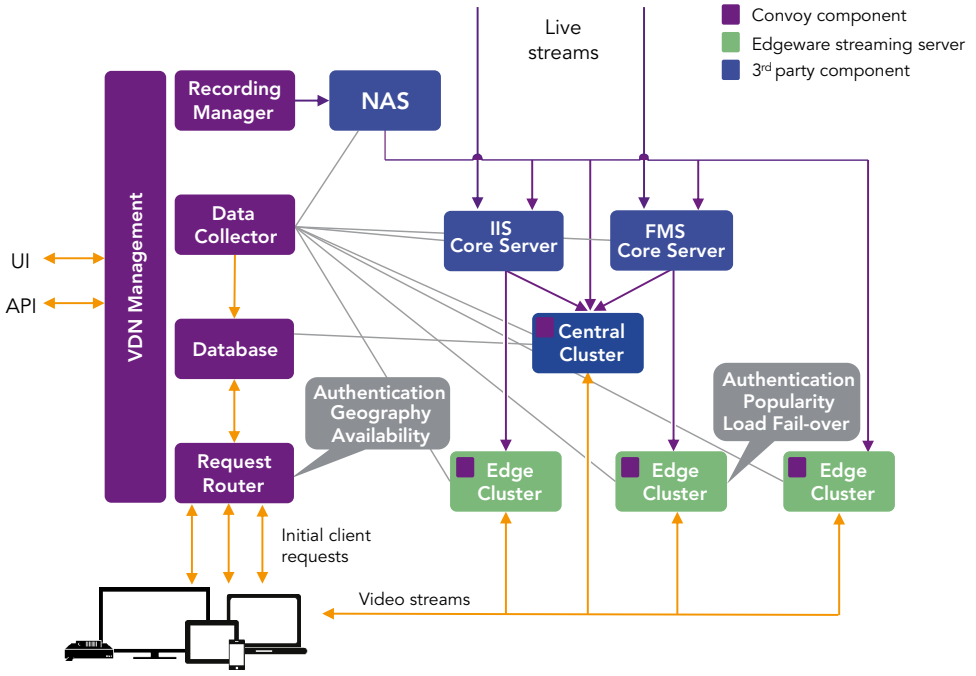
Redirect
The redirect sub system (Request Router) is the client entry point for all content requests. It is the responsibility of the redirect system to find and redirect the client to the best Streaming Server according to client location, content distribution and server load. The redirect system will also provision provider bandwidth according to the provider's contract.

Content delivery
The selected Central and Edge Streaming Servers are responsible of sending the content to the client.

Statistics and Management
Statistics are gathered and presented both to the Management web interface and the relevant API. The redirect and content delivery system use content usage statistics to dynamically reallocate content and client sessions across the delivery servers.

The VDN accounts are setup and modified in the Management API.
Typical account parameters: provider storage quota, bandwidth quota, publishing point and account credentials.
The VDN service is configured in terms of delivery server capabilities, roles and connectivity towards the different networks that the VDN is serving.

Figure 2 *– Convoy VDN System Modules*



Network Topology Configuration

Convoy VDN System Modules

The Convoy VDN System consists of the following core modules:

- Management (web interface + API)
  - Provider account management
  - Service configuration
  - Reporting
- Recording Manager
- Request Router
- Data Collector (log processing and analysis)
- Database

All modules run on standard Linux servers and can be run independently or combined on the same hardware.

The Convoy VDN system is completed with the Convoy VDN Distributed Agent that runs in every Edgeware server that is part of the D-VDN network. This agent is a standard part of the Edgeware server software.

Topology Configuration

Convoy VDN supports topology auto configuration.

Streaming server clusters are mapped to groups of clients based on geographical information and/or IP ranges.

The same IP range and/or location can be assigned to multiple streaming clusters but with different priorities.

The content propagation flow can be defined independently from the client mapping.

The management system then automatically builds all connection information to allow propagation of content and routing of session requests.

nPVR and Time shift TV (Option)

The Convoy VDN System can be upgraded to include an optional nPVR / Catch-up TV Option for all HTTP adaptive protocols.

Convoy VDN can support scheduled capture of live streams, both UDP multicast streams and multi-bitrate HTTP streams. Content is captured on external NAS, through FTP push.

Scheduling is done centrally through the API. Captured video is stored on external NAS, and is available for streaming as soon as the first segments have been captured, i.e. it can be watched during recording.

For multi-bitrate HTTP streams, the

Figure 3 *– Convoy VDN System Modules for nPVR (Example: MS Smooth Streaming)*

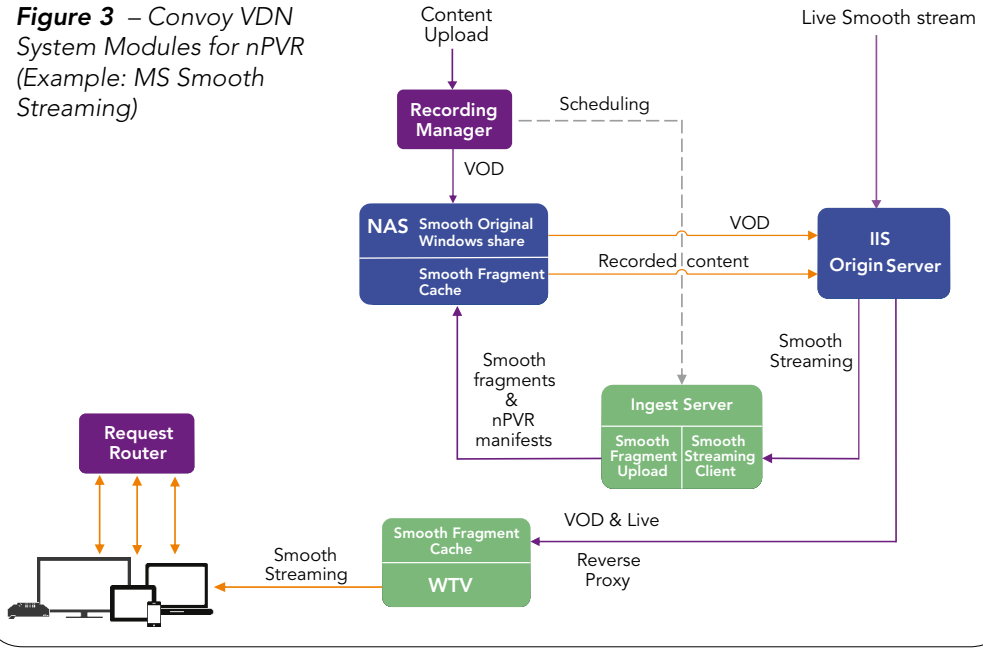


Figure 4 *– Part of the Convoy VDN User Interface*

ingest server acts as a client and will build a new manifest file for the captured content. Changes to the manifest are propagated by the Convoy content distribution system so that clients always have access to the latest version of the manifest.

The adaptive streaming cache distribution can also be used for VOD content.

Live time-shift windows for HTTP adaptive streaming are implemented by the number of available segments presented in the manifest by the encoder.

Interfaces / APIs

VOD content is uploaded through a proprietary API based on REST and JSON

The following interfaces are used:

- Content ingest: FTP/HTTP
- Control API: REST/JSON
- Status report: REST/JSON
- Secure token: URL based token (validated by streaming servers)

Security

All Edgeware servers in the Convoy VDN Management System are protected using:

- Integrated firewalls
- SSL or SSH as management protocols
- Management of the individual servers is typically performed over a dedicated management network using the management ports on the servers. All management protocols are protected using either SSL or SSH
- Support for inline or separate management networks
- DoS protection in hardware
- SYN flood protection in hardware

Access control:

- Content streaming requests sent to the request router can optionally be protected by a signed token that will ensure that the request has been authorized by middleware or portal.
- The redirected request going to the streaming server include be protected with a unique, constantly changing token allowing the video server to block unauthorized acesses.

CDN Federation

Convoy VDN supports CDN Federation using specific content interfaces and requires non Convoy VDN managed VDNs to publish to those interfaces.

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