RayV TV Platform

Highest Quality Streaming - Lowest TCO

White Paper

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Executive Summary

There is no denying that streaming online video has become an integral part of the business landscape, and it is becoming only more essential as time passes.

How can your company leverage this critical tool?

Numerous technologies have been developed to supply online video. This white paper shows, however, that none of the established technologies is fully capable of providing a reliably high-quality user experience, and most of them are prohibitively expensive.

RayV's grid system technology is able to transcend the flaws in other solutions, and provide highest-quality streaming video, to large numbers of viewers, at a fraction of the cost of other solutions.

The Demand for Streaming Online Video

The demand for streaming online video is huge, and continues to grow.

In the United States alone, in June 2010, more than 177 million Internet users watched online video content, constituting 84.6% of the US Internet audience. The average watcher of online video spent over 14.5 hours a month doing so.[1]

During the preceding year, online video watchers in the US increased by 20 million people, and the total amount of time spent watching nearly doubled (from about 7.6 hours per person).[2]

Trends indicate that the global demand will also increase.

As of 2009, nearly 483 million people worldwide had subscriptions to video-capable broadband Internet.[3] Worldwide Internet consumption stood at over 1.95 billion users.[4] As the costs of broadband continue to drop, it can be expected that more and more users will adopt broadband, with its ability to support streaming online video.

Companies are sitting up and taking notice.

In July-August 2009, out of 100 surveyed company websites, 75% featured online video, and in many industries the average was even higher.[5]

Clearly, now is the time to find a solution to enable your company to take advantage of these trends.

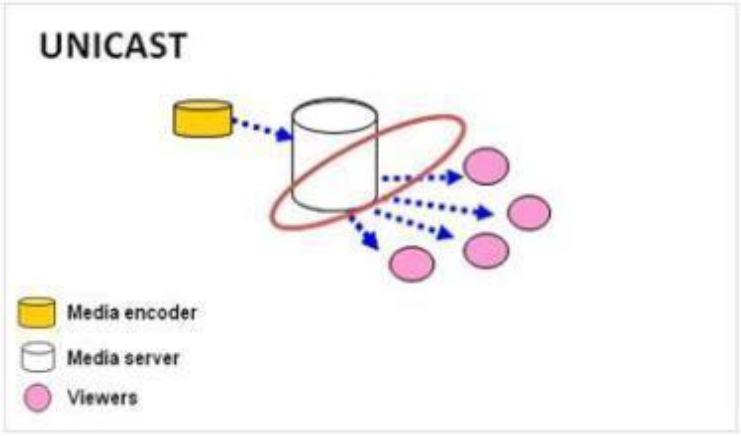
Limitations of Conventional Delivery Schemes

Over the years, various network topologies have been devised to meet the growing need for high-quality content delivery. None is without its flaws.

Unicasting

Live streaming over the Internet is usually achieved using centralized media servers that unicast the stream directly to the end-viewers.

Server-to-client streaming of this kind is inherently inefficient for broadcasting live media over the Internet. As the number of users increase, the bandwidth requirements increase proportionally.



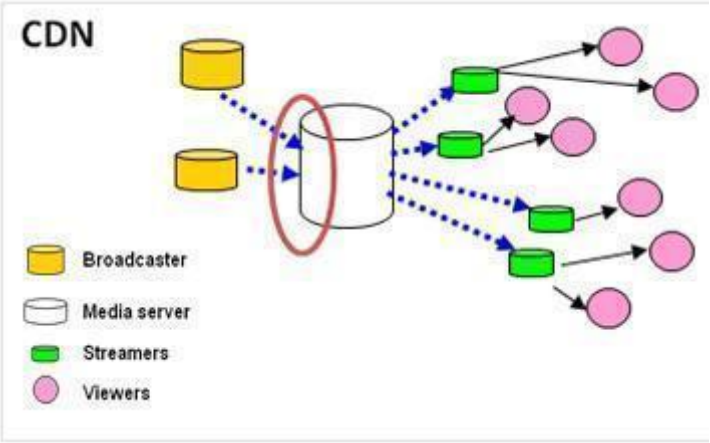
This results in:

- Increased costs.
- Risk of network congestion.
- Reduction in broadcast quality.

Content Delivery Networking (CDN)

In CDN architectures, a media stream is transferred from a broadcaster server to several support CDN servers, each of which serves clients in its designated domain(s). Each CDN server has dedicated storage space and out-bound bandwidth for high-quality media streaming.

The addition of supporting servers does expand the capacity of the broadcaster to accommodate large numbers of end-viewers. However, CDN still suffers from the bandwidth bottlenecks that exist between the media servers and the end-viewers. As a result, just like in unicasting, as the number of users increases, the bandwidth requirements also increase, and with them the general costs and the risks.

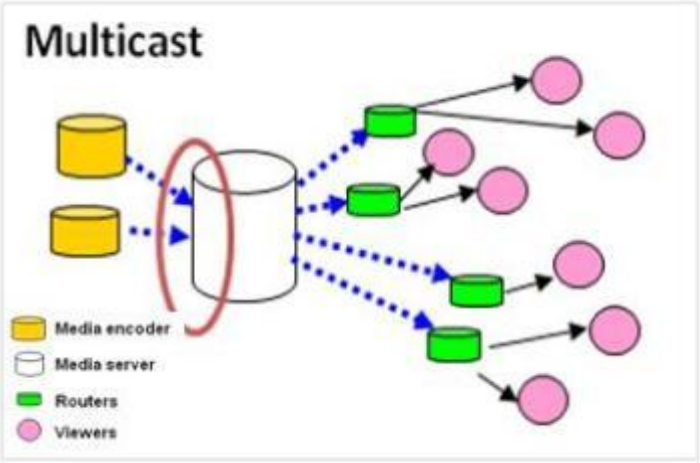


CDN is:

- Expensive to deploy.
- Expensive to maintain.
- Limited in processing power per media file.
- Limited in out-bound bandwidth per media file.
- Prone to network congestion.
- Prone to losses in broadcast quality.

MULTICASTING

IP Multicast is a specific application of multicasting at the IP routing level, and is often employed for streaming media and Internet television applications. The introduction of routers between the media servers and the end-viewers creates optimal distribution paths for the data stream in one-to-many multicast addresses.



However, IP Multicast is still not a perfect solution. Its limitations include:

- High-cost infrastructure.
- Limited conservation of central resources.
- Limited potential for expansion within a given infrastructure.

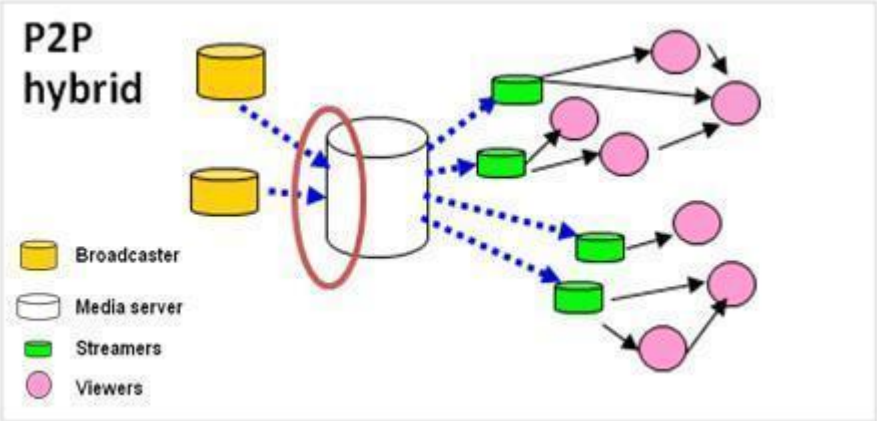
PEER-TO-PEER STREAMING (P2P)

Live streaming over a peer-to-peer network is a relatively new technology.

A single stream is sent from the broadcaster server to the first end-viewer. The first viewer's spare upload capacity is then leveraged to transfer stream data to one or more other viewers. Those viewers, in turn, use their spare upload capacities to transfer data to other viewers, etc. In theory, this enables rabid distribution of the data stream to many end-users, at little cost to the broadcaster. In practice, however, the asymmetry in a viewer PC's download and upload capacity means that P2P is only slightly more efficient than traditional client-server arrangements.

Furthermore, if the number of peers in the P2P swarm is too small, P2P alone cannot provide

sufficient bandwidth to meet the needs of incoming end-viewers. In such situations the broadcaster server must fill the lack by delivering booster streams to all end-viewers who need it. Ultimately, each end-viewer receives a unique stream, an arrangement that suffers from all of the disadvantages of unicasting.



P2P:

- Depends on bandwidth free-riding, and is therefore unreliable.

THE RAYV SOLUTION

RayV's unique system leverages all the advantages of P2P streaming, but introduces additional features to ensure reliable, high-quality service for end-viewers, at an attractive price.

- Amplifiers supplement bandwidth needs.
- Satellite servers provide dedicated streaming to ensure the quality of the stream.
- A Grid Service monitors and manages the network topology to ensure that all resources are being used optimally.

THE RAYV GRID NETWORK

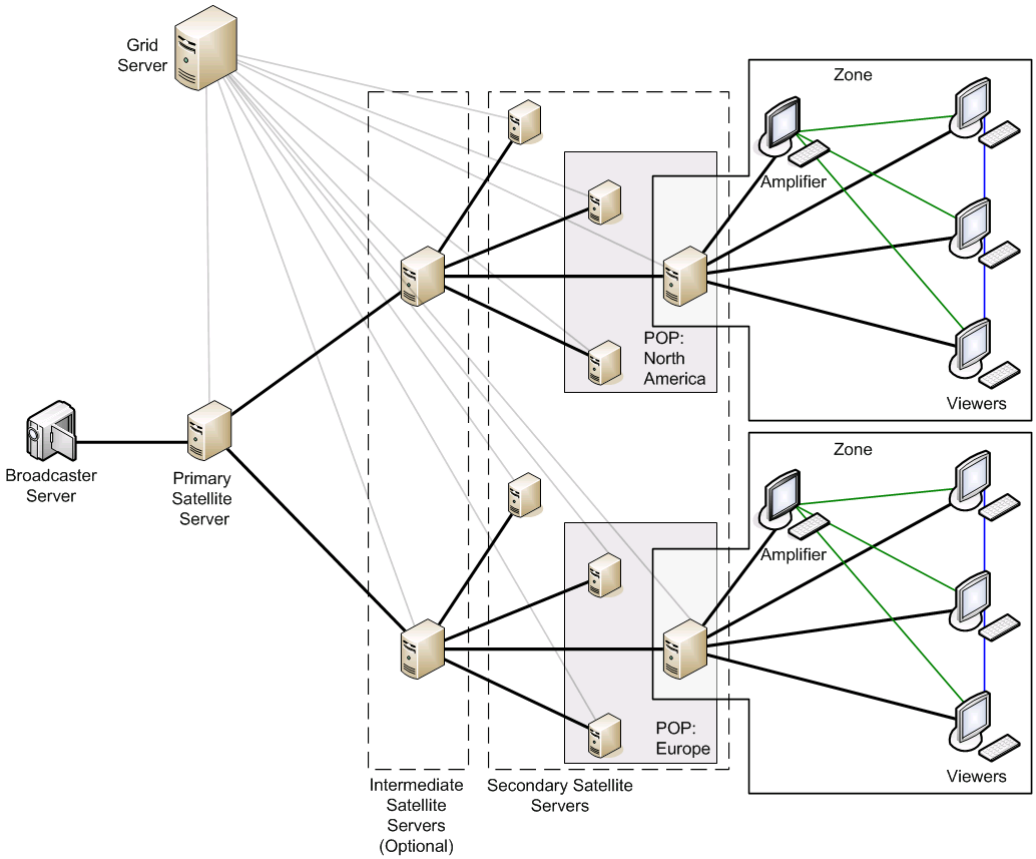


Figure 1: RayV Grid Network – Basic Example for One Channel

The RayV Grid network consists of the following main components:

- Broadcaster Servers – The server from which the video stream originates for each broadcasting channel.
- Satellite Servers – The broadcaster server sends the stream to a hierarchy of satellite servers which stream the video to the end-viewers. These servers function as dedicated nodes for content delivery.
- Viewers – Not merely passive acceptors, viewer PCs also send received data to other viewer PCs to cover lost data packets.
- Amplifiers – Any PC with the RayV plug-in installed which is not currently viewing can be used as an amplifier. A portion of the PC's unused download and upload capacities are used to receive parts of the data stream and multicast them to currently active viewers.
- Grid Service – The RayV grid service monitors all the satellite servers and amplifiers, and allocates these resources to channels as needed.

SURPASSING P2P

The RayV system utilizes viewer PCs in a P2P arrangement. In addition, however, amplifiers supply large amounts of bandwidth beyond the capacity of the viewers' PCs.

By leveraging client resources in these ways, the RayV grid system provides maximally efficient streaming with minimal cost to the broadcaster.

PROVIDING RELIABLE DATA STREAMING

The satellite servers ensure that all viewers have access to one or more dedicated media servers at times when P2P alone is insufficient.

In addition, the RayV grid features a failover CDN, which supports:

- Viewer devices that cannot access the RayV grid directly, such as mobile phones, TV extenders, and viewer PCs behind restrictive firewalls.
- Viewers that prefer to use RayV's flash player instead of downloading the standard RayV plug-in.
- Additional viewers if the RayV grid has exceeded its capacity.

MAXIMIZING THE QUALITY OF THE VIEWER EXPERIENCE

Both satellite servers and amplifiers are managed by a Grid Service. The Grid Service monitors the viewer demand for each channel in the RayV system and applies satellite server and amplifier resources where they are most needed.

In addition to reacting to demand changes as they occur, the Grid Service analyzes the trends of viewer demand to make predictions of how resources will need to be allocated in the immediate future.

THE GRID SERVICE IN DETAIL

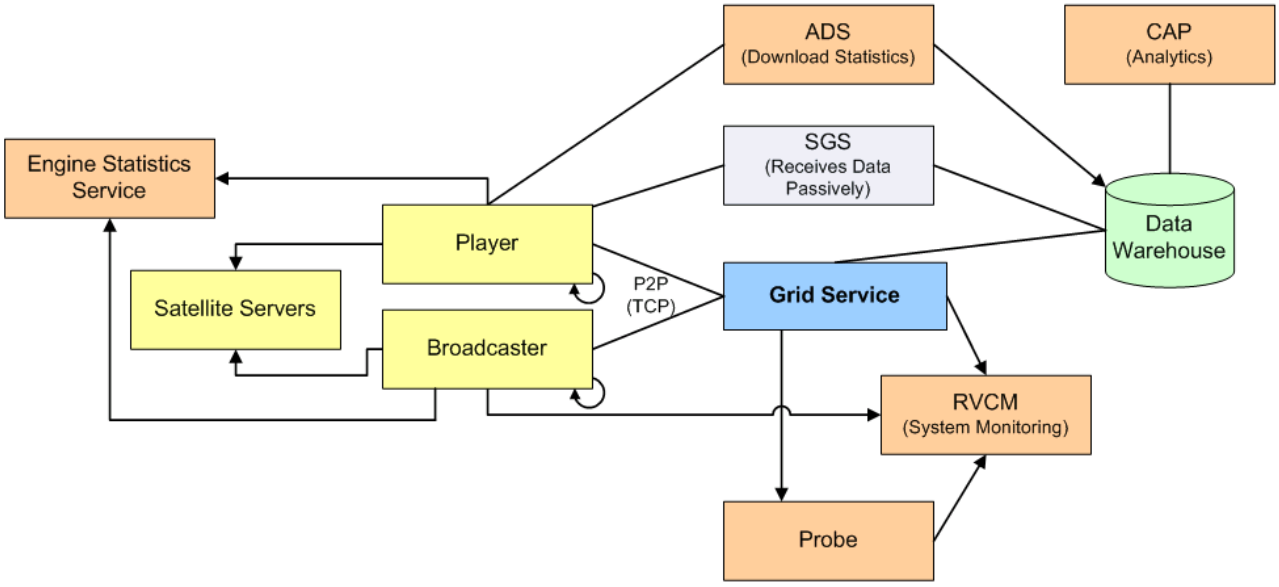


Figure 2: RayV Grid Network

All components of the network, whether computers involved in content delivery, monitoring, databases, data portals, etc. ultimately work though the Grid Service.

This enables the Grid Service to maintain constant awareness of all elements of the network, and to respond according to needs in real time.

How the Grid Service Works

The Grid Service operates within a Windows Server .NET 3.5 or 4.0 platform. External clients accessing the Grid Service communicate via TCP to the grid database, which in turn sends requests to the network of grid servers.

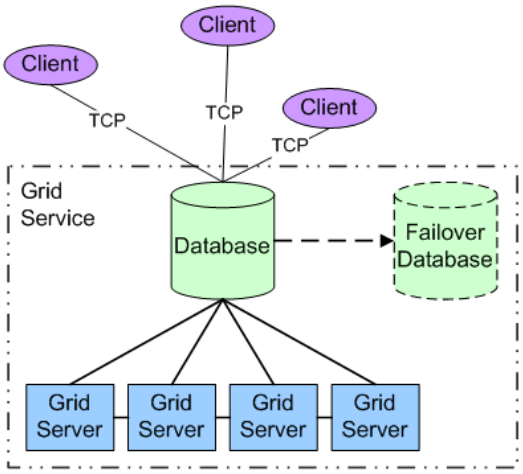


Figure 3: Grid Service Hardware Diagram

RayV's Grid Service utilizes asynchronous communication to minimize latency, and

maximizes the efficiency of requests to the grid servers to the degree that no matter how many clients are participating in the network, the number of requests to the grid servers themselves remains constant.

The grid database manages both grid optimization and short-term data storage. The Grid Service also features a failover database and the long-term storage data warehouse.

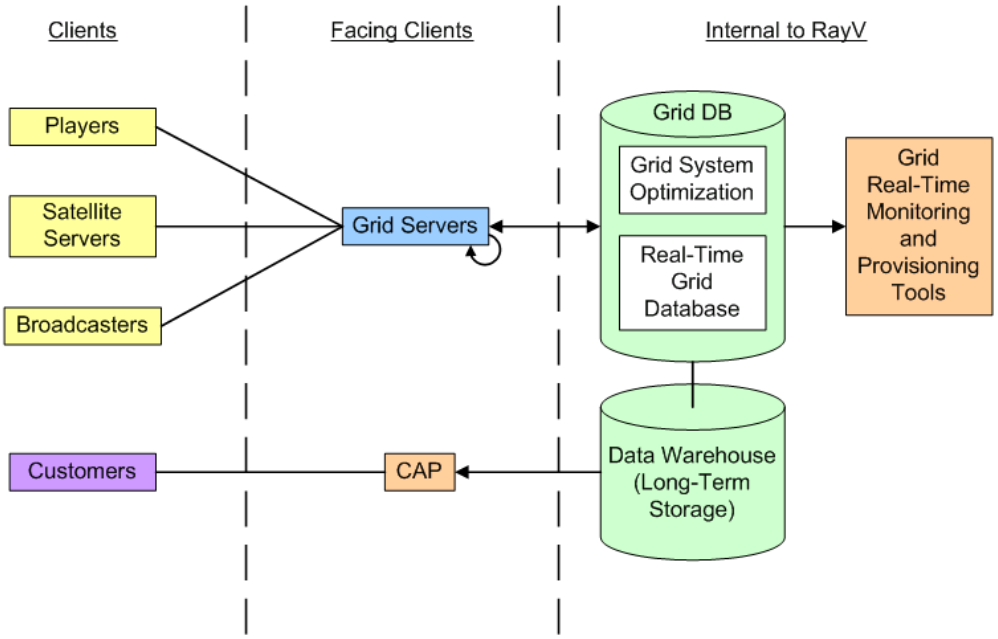


Figure 4: Role-Oriented Grid Service Diagram

FEATURES TO ENSURE HIGH QUALITY OF SERVICE

- Geographical Assignment – The Grid Service determines the geographic locations of viewers. Whenever possible, the Grid Service assigns satellite servers and amplifiers to viewers according to geographical proximity in order to maximize efficiency. Not only does this minimize latency across distances, but it also takes advantage of high speed connections when available between peers, for example, a group of peers sharing a high-speed LAN connection.

  To maximize the advantages of geographical assignment, RayV maintains Points of Presence (POP) on several continents, and groups amplifiers and viewers into precise geographical zones.

- NAT Status-Based Assignment – The Grid Service determines which amplifiers have open NAT policies, and assigns them preferential status for use, ensuring that the more efficient amplifiers are utilized before less efficient ones.
- Server Competition – Available satellite servers are periodically moved between channels on a random basis. With the addition of a server to a channel, the performance of all the servers on the channel is analyzed, and after a defined period of time the server with the lowest performance is dropped. In this way, each channel's resources is constantly being checked and maximized.

- Efficient Packet Recovery – In all digital applications, transferring data across a network invariably results in some data packets being lost. Efficient data packet recovery is an important factor in the quality of the end-viewer experience.

  The RayV system uses a unique algorithm to divide each segment of video into a distinct set of packets. When copies of these packets are distributed throughout the network, any viewer that receives the original number of packets, regardless of which specific packets, is able to reconstruct the original data.

  Every time a node receives a segment of video, it can identify whether it has received all of the data packets for that segment. If it has not, the node can request that the missing number of packets be provided by its nearest available peers.

  Because RayV packet sets are not dependent on the specific packets received, any peer that has received data packets from a given set is likely to be able to provide all the requested missing packets. If peers cannot provide the missing packets, the dedicated satellite servers can always provide them. This ensures that every viewer efficiently receives all the necessary data.

Integrating with Your Business

RayV features a robust API, enabling you to easily integrate your existing infrastructure with the RayV grid system.

Furthermore, the grid system enables you to define rules for system management to ensure that all company policies are implemented as required.

Scaling to Meet Your Needs

The RayV grid system scales upward and outward as you grow. The more viewers you attract, the more amplifiers exist to supplement your bandwidth needs.

Expanding your dedicated RayV infrastructure is as simple as adding additional satellite servers.

Furthermore, RayV's throughput-oriented software design, including I/O in asynchronous batches, direct communication between server instances, and coarse-grained mass caching, makes RayV's service performance and throughput less sensitive to the number of logged-in clients, and more linearly scalable.

Saving You Money

RayV's grid system provides reliable, highest-quality video streaming at a fraction of the cost of other solutions:

- RayV provides the infrastructure, saving you the cost of investing in expensive hardware.
- RayV's unique technology for leveraging viewer PC resources saves you up to 90% of the bandwidth costs associated with other solutions.

COMPARISON SUMMARY

The following table shows the advantage of the RayV network over competing methodologies.

Streaming Comparison	Unicast	Multicast /IPTV	CDN	Other P2P solutions	RayV Grid Streaming
Network topology awareness?	No	Partial	Partial	Yes (with peer selection)	**Yes**
Enables anyone to create their own TV channels?	No	No	No	No	**Yes**
Ability to create bandwidth?	No	No	No	No	**Yes**
Saves on central resources?	No	Partially	Partially	Yes	**Yes**
Ability to expand to millions of concurrent viewers with existing infrastructure?	No	No	No	Yes	**Yes**
Uses resources without free-riding on high bandwidth hubs?	Yes	Yes	Yes	No	**Yes**
Managed network with constant connection to the viewers?	No	In most cases Yes	No	In most cases Yes	**Yes**
Low cost?	No	Expensive infrastructure	Medium Cost	Inherently limited P2P	**Yes, low cost!**

WHY YOU SHOULD CHOOSE RAYV

RayV's strong solution and powerful team are quickly making RayV an industry leader in the field of streaming online video.

With numerous high-profile clients, including DirectTV, Blizzard Entertainment, the NBA, Comcast Sports, Fox Soccer, Europe's AB Group, and Shanghai Media Group, RayV is a vigorous force in the streaming media industry with a truly global presence.

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1 comScore, Inc. <http://www.comscore.com/Press_Events/Press_Releases/2010/7/comScore_Launches_Video_Metrix_2.0_to_Measure_Evolving_Web_Video_Landscape>

2 comScore, Inc. <http://www.comscore.com/Press_Events/Press_Releases/2009/8/Major_News_Stories_Drive_June_Surge_in_U.S._Online_Video_Viewing_to_Record_157_Million_Viewers>

3 Statistics per 100 inhabitants: International Telecommunications Union <http://www.itu.int/ITU-D/ict/material/Telecom09_flyer.pdf>
Statistics regarding world population: Population Reference Bureau <http://www.prb.org/pdf09/09wpds_eng.pdf>

4 Internet World Stats <http://www.internetworldstats.com/stats.htm>

5 VideoBloom VIEW Index <http://www.videobloom.com/view-index/august-2009#100>