A Rohde & Schwarz Company

White Paper

Content Delivery Networks (CDN) for Live TV Streaming

This White Paper presents GMIT's solutions for building and running a streamlined and cost-effective Content Delivery Network (CDN) based on public Internet infrastructure as backbone for IPTV/OTT services, such as live TV in telecommunication networks, Web TV, Internet TV, Over-The-Top TV, or live streaming of arbitrary audio/video content. The major building blocks are introduced, namely TVCaster, CodecCaster, RelayCaster together with RelayCaster Streaming Protocol (RCSP), and PolyCaster. A practical case study is shown, which demonstrates how to set up a complete self-managed CDN within one hour. A video accompanying this document is available at https://www.youtube.com/watch?v=rdY9-3mfI6Y[1]

Keywords

IPTV, OTT, Live TV Streaming, DVB gateway, DVB-S2, DVB-C, DVB-T, DVB-ASI, MPEG-TS, MPEG Transport Stream, Unicast, Multicast, Streaming, UDP, Transcoder, Streaming Server, HLS, HTTP Live Streaming, MPEG-2, MPEG-4, AVC, H.264, Content Delivery Network, CDN, Over-the-top, Web TV, Internet TV

[1] GMIT GmbH, a subsidiary of Munich-based technology group Rohde & Schwarz, has acquired the technology of Motama GmbH.

DVB gateways | Transcoders | Servers for Content Distribution | Streaming Servers

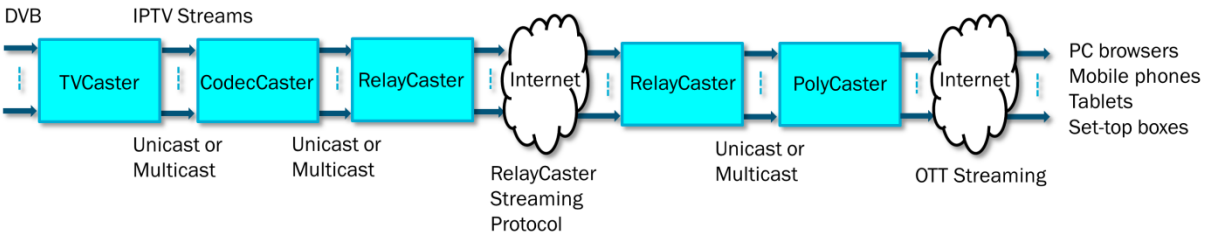

Figure 1

TVCaster, CodecCaster, RelayCaster together with RelayCaster Streaming Protocol (RCSP), and PolyCaster build a stream-lined and cost-effective Content Delivery Network (CDN) as backbone for Internet/OTT.

Introduction

IPTV and OTT solutions by GMIT allow for easily creating and running live TV streaming services. Content of DVB feeds can be converted for IP networking. Content can be transcoded to reduce bandwidth requirements while maintaining a high quality of streams. Content can be distributed in real-time to literally any place in the world. You can even install your own world-wide Content Delivery Network (CDN) within hours.

GMIT's IPTV solutions are stream-lined and cost-effective, which allows for creating attractive business models by serving smaller local audiences with specific offers, as well as larger audiences distributed around the world. This, for example, allows for fulfilling the demand for TV channels for ethnic groups beyond the usual area of content distribution.

GMIT offers a complete set of OTT and IPTV solutions, including DVB gateways, encoders/transcoders, and streaming servers and protocols for content distribution.

- TVCaster is a turn-key solution offering all cutting-edge functionality you expect from an integrated DVB receiver, descrambler, remultiplexer, and IP streaming server. TVCaster servers are available for DVB-S/S2, DVB-C, DVB-T and DVB-ASI.

- CodecCaster offers a high-performance real-time transcoding solution for IPTV streams in MPEG-2 or AVC/H.264 format. The world-class encoder of CodecCaster allows for greatly reducing bandwidth requirements of streams while keeping to the original quality, which makes CodecCaster the ideal tool for supporting multiple devices and screens, and adaptive streaming at different bitrates using HTTP Live Streaming (HLS) and other protocols.

- RelayCaster servers together with RelayCaster Streaming Protocol (RCSP) offer a turnkey solution that enables optimized transmission of IPTV streams. With RelayCaster, reliability and data rates of distributing live content can be greatly improved, and packet loss issues can be

solved efficiently. RelayCaster allows replacing expensive satellite links or expensive contracts with CDN service providers.

- PolyCaster by GMIT is a turn-key streaming server available as 19-inch rack mountable appliance that comes with an easy-to-use web interface. PolyCaster enables you to distribute live streams to a broad range of devices, including PC browser, mobile phones, tablets, and set-top boxes. PolyCaster supports the major streaming formats and protocols, including Adaptive Bitrate Streaming (ABR).

All products are available as turn-key server appliances. CodecCaster and RelayCaster are also available as software-only packages for easy installation on existing servers hosted in data centers.

Figure 1 shows an overview of the combination of the four products. TVCaster servers allow for converting live feeds from DVB-S/S2, DVB-C, DVB-T or DVB-ASI to IPTV streams. These streams can be transcoded with CodecCaster before RelayCaster servers together with RelayCaster Streaming Protocol (RCSP) handle the Internet-wide distribution of live streams. In particular, the first RelayCaster server transmits streams using RCSP to a second RelayCaster server located in a remote data center. Finally, streams can be served by PolyCaster to OTT clients, such as set-top boxes, mobile phones, tablets, and PC browsers, using common streaming protocols.

Together, this allows GMIT's customers to have a single point of contact for building their own full-featured Content Delivery Network (CDN). All building blocks of this network will be explained in more detail in the following sections.

DVB Gateway: TVCaster

TVCaster by GMIT represents the next generation of IPTV server appliances for DVB-to-IP-conversion. TVCaster is a turn-key solution offering all cutting-edge functionality you expect from an integrated DVB receiver, descrambler, remultiplexer, and IP streaming server.

TVCaster servers are available in various configurations:

- TVCaster servers are available for DVB-S/S2, -C, -T, and -ASI, and combinations thereof.
- TVCaster servers offer different numbers of inputs and Common Interface (CI) slots for descrambling of Pay-TV with the corresponding smartcard and Conditional Access Module (CAM).

Typically, you will not exactly know how many DVB inputs you require for building your IPTV service. You will more likely have a list of TV and radio channels you would like to provide to your customers. Starting from this list, you need to determine the DVB sources providing these channels, such as satellite providers, etc.

Then, you need to determine how the channels are 'aggregated'. To fully understand this concept, it is important to review the capabilities of DVB tuners. Each tuner can only tune to a certain transponder (also called bouquet) at a time, which is specified by a number of technical parameters, such as a frequency. On such a transponder, you will find a number of different TV and radio channels. For example, a typical DVB-S2 transponder for SDTV will provide between 5 and 10 different TV channels; for DVB-S2 between 2-4 different HDTV channels are available.

How channels are assigned to different transponders is predefined by your provider. You need to consult your satellite or terrestrial provider for a complete list of transponders. Based on this information and the selection of channels you would like to stream, you can then determine how many DVB inputs you need. Then, you can select the types and numbers of TVCaster products to fulfill your requirements.

If you later find that you would like to include additional TV or radio channels into your TV service, you can simply plug in additional TVCaster servers to your network and thereby seamlessly increase the number of accessible DVB transponders. Of course, you can also attach DVB feeds from different sources to a single TVCaster system, such as two different satellites dishes.

One of the main features of the TVCaster is to be able to re-transmit each TV or radio channel of a transponder as separate IP stream to your network. This is referred to as remultiplexing from MPEG Multi-Program Transport Stream (MPTS) to a number of Single-Program Transport Streams (SPTS), i.e. going from a single DVB transponder to a number of IP streams, one for each TV or radio channel. This feature is important since it allows for handling each individual channels as individual stream. Providing separate IP streams also allows for a more fine-grained access of content and therefore avoids wasting network bandwidth.

Transcoding: CodecCaster

When creating a Content Delivery Network, bandwidth is a crucial point. Original DVB streams in SD resolution are typically available at bandwidths from 5 Mbps to 10 Mbps. For HDTV, 15 to 20 Mbps are used – for only a single TV channel.

CodecCaster is a turn-key solution for real-time transcoding of IPTV streams. It offers high-performance and high-quality IP-based format conversion. Most importantly, it supports video transcoding from MPEG-2 Video to MPEG-4 AVC/H.264 for MPEG Transport Streams in SD and HD resolution.
The world-class encoder of CodecCaster allows for greatly reducing bandwidth requirements of streams while keeping the original quality of experience, which makes CodecCaster the perfect solution for Internet transmission. CodecCaster also fully supports transcoding to different bitrates from a single input streams. This allows for feeding streaming servers supporting adaptive bitrate streaming (ABR).

When setting up your Content Delivery Network (CDN), IP streams from TVCaster will be transcoded with CodecCaster. As an example, a TV channel in SD resolution at 10 Mbps total bandwidth can be transcoded to 1.3 to 2.0 Mbps with only very little decrease in image quality.

Additional options for stream adaption, such as deinterlacing, video scaling or frame rate conversion, allow for serving set-top boxes, tablets, mobile phones, and other devices.

The number of streams to be transcoded in parallel is not artificially limited. This means you can add as many streams and profiles as you want – until the system is fully loaded. Please refer to our latest data sheets for precise performance specification.

Contribution and Distribution: RelayCaster

RelayCaster offers WAN optimization for data-center-to-data-center transmission. RelayCaster server appliances offer a turn-key solution that enables optimized contribution and distribution of live IP streams for OTT and IPTV. By using the RelayCaster Streaming Protocol (RCSP), reliability and data rates of streaming live content along lossy long distance links can be greatly improved. RelayCaster servers allow for building cost-effective Content Delivery Networks (CDN) using public Internet infrastructure.

Figure 1 shows the usage of two RelayCaster streaming servers. Using the RelayCaster Streaming Protocol (RCSP) between two RelayCaster servers allows for the optimized transmission of IPTV streams to remote company sites, data centers, or networks. On one side, a RelayCaster server receives IPTV streams available as plain UDP unicast or multicast in the local area network (LAN) and then re-transmits these streams using RCSP to a second RelayCaster server, possibly located on a continent far away. The receiving server then forwards the streams to the local area network it is connected to, again as plain UDP unicast or multicast, to allow for further processing of streams.

Of course, RelayCaster servers also allow for scaling your Content Delivery Network (CDN) by creating more complex setups, for example star-shaped or tree-shaped networks of RelayCaster servers (see Figure 2).

Compared to streaming with existing unreliable protocols, such as UDP or RTP, GMIT's RCSP greatly reduces packet loss. Even packet loss rates of several percent, jittering, or short break-downs of connectivity can be compensated for.

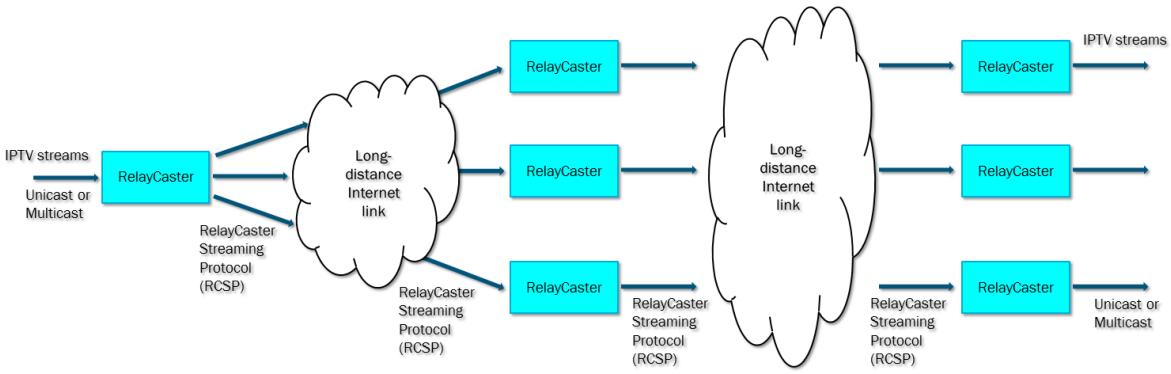

Figure 2

A tree-shaped Content Delivery Network (CDN) built of RelayCaster servers: IPTV streams from a central data center are re-distributed to various intermediate and terminating data centers that are spread around the world.

Compared to content distribution with reliable protocols, such as TCP or higher-level protocols such as FTP or HTTP, the new streaming protocol RCSP offers much higher bandwidths for transmission of live content over lossy long distance links or within wireless networks.

Streaming to end users: PolyCaster

As can be seen in Figure 1, IPTV streams received by the second RelayCaster will be forwarded as plaind UDP unicast or multicast to the local area network it is connected to. Within this network, streams can then be further processed by existing equipment, or forwarded to end-users' clients directly, for example using multicast networking in a managed telecommunication network. Streams can also be forwarded to OTT streaming servers.

PolyCaster by GMIT is a turn-key streaming server that comes with an easy-to-use web interface. PolyCaster enables you to distribute live streams to a broad range of devices, including PC browser, mobile phones, tablets, and set-top boxes. PolyCaster supports the major streaming formats and protocols and protocols, including Adaptive Bitrate Streaming (ABR), for bridging the last-mile to nearby end users. These protocols are typically based on HTTP, for example HTTP Live Streaming (HLS). Within GMIT's OTT backbone, PolyCaster is used as edge server for Over-the-Top (OTT) streaming in the Internet.

Discussion: RelayCaster vs. PolyCaster

Please note that any such OTT streaming server needs to be located very closely to users in terms of network delay. Otherwise, streaming will not work satisfactory, in particular if TCP based protocols are used, which is the case for all HTTP based protocols. Other existing techniques, such as prefetching

and buffering larger amounts of data before playback is started (also called progressive download), are also not acceptable: First, the large start-up delays of such techniques forbid any kind of interactive applications, such as channel hopping of live TV streams. Second, using TCP based protocols along long-distance links will most often not result in sufficient throughput.

To summarize, any kind of IPTV or OTT service bridging long-distance links requires a mature backbone, which optimizes the real-time transmission over lossy long-distance links. Therefore, for distribution live streams to data centers nearby end-users, RelayCaster servers together with RelayCaster Streaming Protocol (RCSP) need to be employed. This also offers the advantage that each TV stream is only forwarded once between different data centers, possibly located on different continents of the world. Only when streams are within the 'proximity' of end users, an individual stream needs to be created for each TV channel the user requests.

Case study: Setting up your own CDN within one hour

We will now walk through the complete set up of a Content Delivery Network (CDN) based on TVCaster, CodecCaster, RelayCaster together with RelayCaster Streaming Protocol (RCSP), and PolyCaster. This setup is shown in Figure 1. To keep it simple, there will be only one TVCaster, one CodecCaster, and one RelayCaster server co-located in one data center for sending, and only one RelayCaster for receiving and one PolyCaster for streaming to end users in a remote data center.

All systems are connected to the network, and the web interfaces are accessible from your browser. DVB inputs of the TVCaster server are connected to satellite feeds. The two RelayCaster servers have a link to the external network, i.e. the Internet.

For building a cost-effective Content Delivery Network, the two data centers are only connected by public Internet infrastructure. Of course, you need to make sure that the available outgoing Internet bandwidth of the first RelayCaster, and the available incoming Internet bandwidth of the second RelayCaster matches your overall required bandwidth.

Step 1: Minute 1 to 10: TVCaster

Log in to the web interface of the TVCaster server. After running the channel search or manually configuring your DVB inputs, you need to assign both tuners to corporate mode. This mode allows for creating unicast or multicast IPTV streams. Then, you need to select the transponders each tuner out of the list of all available transponders by simply selecting any channel available on that particular transponder. In the next dialog, you will see all available TV and radio channels of the currently tuned transponders of all DVB inputs. Simply create a stream for each channel to be provided in your TV service.

Since outgoing streams of the TVCaster server used in our case study are to be forwarded to the CodecCaster server co-located in the same data center and local area network, you will create UDP unicast or multicast streams that can be access by the CodecCaster in the local area network.

Step 2: Minute 10 to 20: CodecCaster

Log in to the web interface of the CodecCaster server. Then, for each IPTV stream sent by the TVCaster server, create a transcoded stream to be sent to the RelayCaster server co-located within our network. You need to enter the corresponding unicast or multicast address of each incoming stream, and specify the bitrate of each outgoing video stream together with a unicast or multicast address to reach the the RelayCaster server, which is located in the same data center, and a unique port number of each outgoing stream. Of course, you can further define how to transcode the incoming streams by changing options in the advanced dialog, or you can create multiple output streams with different bitrates for each incoming stream, which are to be used by PolyCaster in step for adaptive streaming to OTT client devices.

Step 3: Minute 20 to 30: Sending RelayCaster

Log in to the web interface of the first RelayCaster server that is co-located within the same data center as the TVCaster and CodecCaster. Then, for each transcoded IPTV stream sent by the CodecCaster server, create a stream to be sent to the second RelayCaster located within the remote data center.

In this step, you need to enter the corresponding port number of each incoming stream, and specify the IP address of the second RelayCaster server and a unique port number of each outgoing stream.

Since the second RelayCaster is possibly located on a different continent and only connected by public Internet infrastructure, you want to use the RelayCaster Streaming Protocol (RCSP) for streaming between the two RelayCaster servers. Therefore, you select UDP as incoming protocol for the streams provided by CodecCaster, and RCSP as outgoing protocol. If the default parameters of RCSP are not matching your outgoing link, only a few values need to be changed in the advanced dialog for further optimizing the streaming.

Step 4: Minute 30 to 40: Receiving RelayCaster

Log in to the web interface of the second RelayCaster server that is located within another data center, possibly on a different continent than the other servers. Then, create a stream for each stream sent from the first RelayCaster server to this RelayCaster (see previous step). You need to select RCSP as input protocol, and UDP as output protocol. If the default parameters of RCSP are not matching your incoming link, only a few values need to be changed in the advanced dialog for further optimizing the streaming. For the outgoing streams, you can select multicast addresses, or unicast addresses of the PolyCaster server located in the same local area network and data center.

Step 5: Minute 40 to 50: OTT Streaming with PolyCaster

Log in to the web interface of the PolyCaster server. Create different streams or groups of streams for adaptive streaming. Finally select the list of supported streaming protocols, and set up any other option of PolyCaster that is important for you.

Step 6: Minute 50 to 60: Client Devices

Test the available client devices for OTT streaming, such as set-top boxes, mobile phones, tablets or PC browsers. Links to quickly testing streams are automatically provided by the web interface of PolyCaster.

Scaling your CDN

As shown in Figure 3, your CDN can easily be scaled to serve OTT streaming servers in different regions or countries: At a central location, TV streams are received from DVB feeds, converted to IP, transcoded to multiple bitrates, and then contributed to different regions by RelayCaster. Content is thereby pushed 'close' to end-users before OTT streaming is used.

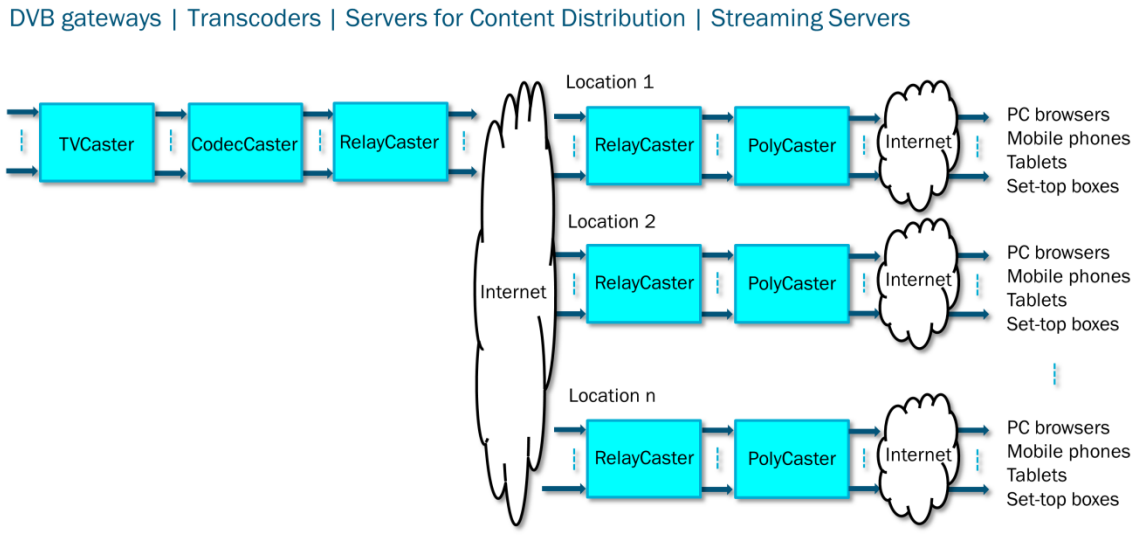

Figure 3

A CDN for Internet/OTT streaming contributing live streams to different locations.

Summary

This White Paper introduced GMIT's server products, namely TVCaster, CodecCaster, RelayCaster together with RelayCaster Streaming Protocol (RCSP), and PolyCaster. We explained how to build and run a customized stream-lined and cost-effective Content Delivery Network on top of these servers. A case-study demonstrated the complete set up of an OTT/IPTV service within only one hour that included receiving DVB feeds, transcoding of streams, content distribution to remote data centers, and OTT streaming to different devices.

GMIT

GMIT - a Rohde & Schwarz company develops multiviewer and automated monitoring products for operating and monitoring broadcast and streaming infrastructures. These products feature top performance and availability and are based on GMIT software components and technologies for processing video, audio and data in realtime. With the acquisition of the technology of Motama GmbH, the product portfolio was extended in the areas of IP contribution, live transcoding, OTT streaming and DVB gateways.

Further information about GMIT is available from https://www.gmit-gmbh.de/