R&S® IPGW
RelayCaster One / 200 / 1000 / Encoder
User Manual

2119503002

ROHDE & SCHWARZ

This document describes the usage of the software 'RelayCaster' or 'RelayCaster Lite'.

Please carefully read these instructions. Please change all passwords mentioned in the following. Notice that any changes of the configuration of the system, which are not described in the following, will render your warranty void. So, please do not use any other configuration tool, and do not manually change the system or network configuration by editing files.

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol, e.g. R&S®IPGW is indicated as R&S IPGW.

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Latin America	Phone +1-410-910-7988 customersupport.la@rohde-schwarz.com
Asia/Pacific	Phone +65 65 13 04 88 customersupport.asia@rohde-schwarz.com
China	Phone +86-800-810-8228 / +86-400-650-5896 customersupport.china@rohde-schwarz.com

Contents

1 What's New in this Version

Revision	Comment
November 01, 2018	Initial Version for Rohde & Schwarz
November 21, 2018	Added section about network settings via webinterface. Added SRT support. Added NTP status information.

2 Accessing the Web Interface

To access the web interface of the RelayCaster, start your web browser and connect to `http://<IP_ADDRESS_OF_RELAYCASTER>` (e.g. http://192.168.1.254) or `https://<IP_ADDRESS_OF_RELAYCASTER>` (e.g. https://192.168.1.254).

When connecting using https you need to confirm the certificate.

Table 2. https certificate

Serial Number	00:B6:DB:C0:A8:A6:0D:20:22
MD5 Fingerprint	9D:69:73:36:5F:7D:86:44:9D:49:27:CA:0E:1F:81:EA

To pass the authentication, you need to provide the user name and the password, which defaults to:

Table 3. Authentification factory defaults

username	password
admin	password

The web interface consists of the following configuration pages:

- **Encode:** Add, remove, or modify encode streams. In addition, different system benchmarks are shown, which are also visible on the display integrated into the device itself.

- **Streams:** Add, remove, or modify streams. In addition, different system benchmarks are shown, which are also visible on the display integrated into the device itself.

- **Help:** Documentation: installation manual, user manual, changelog.

- **Info:** General settings, import and export of current configuration, NTP status, release information, and log files.

- **Login/Logout:** The page 'Login' is shown if you are not logged in to the RelayCaster system, otherwise 'Logout' is shown. By selecting these pages you can either login or logout from RelayCaster.

3 Adding an Encode Stream

- Access the web interface.

- Login with username and password.

- Ensure that an SDI or HDMI signal is connected to the server. Please note that only SD and HD signals up to 1.5GBit/s are supported.

- Select the configuration page **Encode**.

    o Section **Create New Encode Stream**:

        - Note: RelayCaster Encoder software allows for creating only one encode stream up to 25MBit/s.

        - **Encode name**: You may assign any encode stream identifier.

        - **Input Jack**: Either SDI or HDMI can be selected as video input.

        - **Input Format:** All supported video formats are show in this selectbox. If the selected format does not match the currently provided signal, color bars will be encoded. You may choose "Auto" for auto-detection.

        - **Output address and Output UDP port** specify the destination IP/port of the encoded stream. If the stream was created successfully the port will be incremented. The encoder can only send UDP streams. If you need RTP/RCSP you have to send the stream to localhost and use a RelayCaster stream to convert it. The network interface where the output stream should be sent on can be selected with "General Network Settings" in "Info" tab.

        - **Video Bitrate:** Set the initial transport stream video bitrate in kBit/s. The elementary video bitrate will be slightly smaller to compensate transport stream multiplexing overhead. This setting can be updated later while the stream is running. This change happens without transitional artefacts in the video when the change is either up or down in a limited step size. The encoder has to do some bitrate planning which fails if the bitrate gets lowered too much. Allowed range is 400 - 25000. If "Adaptive Bitrate" is enabled this value will be updated automatically by the Adaptive Bitrate Controller.

        - In the **Advanced** configuration dialog you can specify the following settings for **Video**

            - **Codec**: H.264 or MPEG-2

            - **Profile**: The available settings depend on the selected codec. Be aware that also the input resolution and bitrate might restrict the allowed options.

            - **Level**: The available settings depend on the selected codec. Be aware that also the input resolution and bitrate might restrict the allowed options.

- **GOP-Size**: Group of pictures size in number of frames. The allowed range is 1 to 300. The actual GOP size depends on the video to be encoded and may be smaller than this configured number. For MPEG-2 only even numbers are working as expected. For H.264 only multiple of 3 are working as expected.

In the **Advanced** configuration dialog, you can specify the following settings for **Audio**

- **Codec**: Disable, MP1L2, AAC-LC, HE-AAC-v1, HE-AAC-v2

- **Channels**: Mono, Stereo, Dual Mono, Surround 5.1 (the supported channel mapping depends on the selected Codec)

- **Bitrate**: ES Bitrate in the range: 32-640 kBit/s. The supported bitrate depends on the selected codec and Channel mapping. The TS bitrate on the Audio PID will be slightly larger by about 50 kBit/s than the selected bitrate.

In the **Advanced** configuration dialog you can specify the following settings for **Muxer**

- **TS-Bitrate**: Configure the overall bitrate in kBit/s for the transport stream. If this value is smaller than the minimum required for current audio and video settings it will be set to that minimum. The maximum allowed bitrate is 35000 kBit/s.

In the **Advanced** configuration dialog you can specify the following settings for **Adaptive**

- **Enabled**: "Yes"/"No": Switch Adaptive Bitrate Controller On or off. "Latest Statistics" in the receiving RCSP stream must also be enabled for Adaptive Bitrate Controller to work.

- **Min Bitrate**: The minimum TS-Muxer bitrate the Adaptive Bitrate Controller may use. Configurable minimal value is 2500

- **Max Bitrate**: The maximum TS-Muxer bitrate the Adaptive Bitrate Controller may use.

NOTE: This is the first release of the Adaptive Bitrate Controller. It is necessary to have at least this version running on the receive side and the advanced RCSP option "Latest Statistics" must be enabled. The algorithm starts by setting the bitrate to the average of "Min Bitrate" and "Max Bitrate". It then tries to increase the bitrate toward the maximum quite slowly to not overrun a bandwidth limited channel too often. The decrease in bitrate might be fast if the available channel bandwidth drops quickly. Keep in mind that the configured bitrates are TS-Muxer bitrates where internet links are normally described by IP-Bitrates which is about 6% higher than the TS-Muxer bitrate. If you have for example a 10MBit/s internet link the available TS-Bitrate is about 9.4MBit/s (10MBit/s * 0.94).

- Click the **Create** button to create the stream and save the configuration. If the stream is created, it is listed in Section **Modify Encode Stream** on the same page. You should see a green symbol in the status column if the stream is started. If the stream could not be started or was stopped a red symbol will appear. If the RelayCaster Encoder recognizes a problem, the symbol turns yellow. The status will be updated every 10 seconds, if you want to manually update the information please reload the Encode page (for example, by clicking on the 'Encode' tab).

- Click the **Defaults** button to restore all default settings in this section.

4 Destroying or Stopping an Encode Stream

- Access the web interface.

- Login with username and password.

- Select the configuration page **Encode**.

    o Select the wanted stream in the table **Modify Encode Streams**.

    o To destroy the stream, click the **Destroy** button. The stream will be removed from the table after confirming the warning dialog.

    o To stop the stream, click the **Stop** button. You should see a red symbol in the status column. A stopped stream can be re-started by then clicking the **Start** button.

5 Modifying an Encode Stream

- Access the web interface.

- Login with username and password.

- Select the configuration page **Encode**.

  Section **Modify Encode Stream** lists available streams. This section refreshes automatically every 10 seconds. This refresh is stopped while a modification is pending (the "Modify" button is enabled) or the "Advanced Settings" popup is open.

  o Select the wanted stream in the table **Modify Encode Stream**.

  o **Video Bitrate** allows to change the video bitrate without interruption of the stream

  o Click the **Modify** button to modify the stream and save the configuration. A green symbol signalizes that the stream could be modified whereas a red symbol will appear if this failed.

6 Adding a Stream (RelayCaster)

- Access the web interface.

- Login with username and password.

- Ensure that the stream to be recasted is streamed to the RelayCaster's address, or a multicast address.

- Select the configuration page **Streams**.

  o Section **Create New Stream**:

    ▪ Note: In general, RelayCaster software allows for creating an arbitrary number of streams. Before creating a new stream please check that the maximum number of supported streams will not be exceeded. Please refer to the technical specification of the system to see how many streams are supported in parallel. How to check the information about running streams as well as other system information is described in Section 9

       RelayCaster Lite (Software-Only) is a special version of RelayCaster that allows to create only one stream with up to 15 Mbps. If more than 15 Mbps is streamed, the RelayCaster Lite version can at any time stop to process the stream.

    ▪ You may assign a stream identifier in the table **Stream name**.

    ▪ Type in the stream source the columns **Input address** and **Input port**. If the stream was created successfully the port will be incremented.

       Note: The default input address is either the IP of this RelayCaster system (when receiving unicast), or the multicast address of the incoming stream.

    ▪ Type in the streaming destination in the columns **Output address** and **Output port**. If the stream was created successfully the port will be incremented.

       Important note: All streams that are sent to a multicast address are sent through the selected interface in the "General Network Settings" on the Info page (see Section 11).

    ▪ Select the protocol of the incoming stream in the column **Input protocol**. The four streaming protocols supported by the RelayCaster system are:

      - Raw-UDP

      - RelayCaster Streaming Protocol (RCSP).

      - RTP

      - Secure Reliable Transport (SRT)

- Select the protocol the outgoing stream is to be transmitted in in the column **Output protocol**. These four streaming protocols are supported by the RelayCaster system:

    - Raw-UDP

    - RelayCaster Streaming Protocol (RCSP).

    - RTP

    - Secure Reliable Transport (SRT)

        - **Note: it is currently not supported to have input and output set to SRT**
        - **Note: SRT Rendezvous mode is currently not supported**

- In the advanced configuration dialog, you can specify the following settings to enable/disable MPEG transport stream continuity statistics:

    - MPEG-TS Cont. Counter Check: Choose Enable/Disable from the drop-down list.

- And the following settings when using UDP or RTP as output protocol:

    - Sender TTL (Optional): Specifies the time to live value for outgoing stream. The default value is 0 which uses a TTL value of 1 for multicast streams and a value of 64 for unicast streams.

        Important note: This value can have impact on how the streams are forwarded in your network environment. So you should be familiar with the meaning of this value before changing the default value.

- And the following for AES Encryption when using UDP or RCSP as output protocol:

    - Encryption Key (Optional): Specifies the key which should be used for the encryption. The encryption will be enabled if and only if this field is not empty. Note: You have to insert a Key with at least as many bits mentioned in the Encryption Strength Box.

    - Encryption IV (Required if Encryption Key is not empty): Specifies the initial vector which should be used for the encryption. Note: You have to insert an IV with at least as many bits mentioned in the Encryption Strength Box. The IV is a security parameter for data-encryption. It prevents the user for dictionary attacks, for example if two messages contain the same text, than the hacker could assume, that both ciphertexts are the same and this is indeed the fact if you wouldn't use an iv. However different iv's on each message will have the result, that each ciphertext will be different, even if the message and the key are the same.

    - Encryption Strength: Specifies the Cipher strength of the encryption that means if you select 128 then a 128 bit encryption will be used.

    - Important note: AES encryption is not supported if you use RTP as output protocol

Important note 2: The Key will be masked with the Relaycaster, so it is only possible to decrypt this stream with another RelayCaster

Important note 3: It is only allowed to have one decrypting stream for a specific input address (and port). If you want to have decrypt the stream within an internal loop and then create multiple normal streams.

Important note 4: It is not allowed to have both: one decrypting stream and a normal (non decrypting) stream for a specific input address (and port).

The following is an example of such an internal loop for multiple decryption: Assuming to have an incoming encrypted stream on address A, your RelayCaster may have address R and you will send this stream to address B and C. Then you have to the following: First create a decryption stream with input address A and output address R, then create a normal stream with input address R and output address B and last create a second normal stream with input address R and output address C

- And the following For AES Decryption when using UDP or RCSP as input protocol:

  - Decryption Key (Optional): Specifies the key which should be used for the decryption. The decryption will be enabled if and only if this field is not empty. Note: You have to insert a Key with at least as many bits mentioned in the Decryption Strength Box

  - Decryption IV (Required if Decryption Key is not empty): Specifies the initial vector which should be used for the decryption. Note: You have to insert an iv with at least as many bits mentioned in the decryption Strength Box

  - Decryption Strength: Specifies the Cipher strength of the decryption that means if you select 128 then a 128 bit will be used.

  - Important note: AES decryption is not supported if you use RTP as input protocol

    Important note 2: The Key will be masked with the Relaycaster, so it is only possible to decrypt incoming Streams from another RelayCaster

    Important note 3: It is only allowed to have one encrypting Stream for a specific input address (and port). If you want to have multiple encrypting streams you have to build a internal loop.

    Important note 4: It is not allowed to have both: one encrypting stream and a normal (non encrypting) stream for a specific input address (and port)

The following is an example of such an internal loop for multiple en-cryption: Assuming to have an incoming stream on address A, your RelayCaster may have address R and you will send this stream to ad-dress B and C (but encrypted) Then you have to the following: First create a stream with input address A and output address R1 (with R1 as address R with random port) then create a encrypted stream with input address R and output address B secondly create a another stream with input address A and output address R2 (with R2 as ad-dress with random port, different from R1) and last create a second encrypted stream with input address R and output address C

- The RelayCaster Streaming Protocol requires additional information. Click the image in the column Adv to open the advanced configuration dialog. In this dialog you can specify the following settings when using RCSP as input protocol:

  - Dejitter Filter: Enable this when the stream has jitter issues. Make sure the sending RCSP stream configuration also has this option set.

  - Latest Statistics: Enabled this when receiving a stream via the Re-layCaster Streaming Protocol (RCSP) in combination with Adaptive Bi-trate Controller in Encoder.

  - RCSP sender address: When receiving a stream via the RelayCaster Streaming Protocol (RCSP), enter the IP address of the host that sends the RCSP stream here.

  - RCSP input port: When receiving a stream via the RelayCaster Streaming Protocol (RCSP), enter the RCSP port of the sender here. Note: This port has to be identically with the RCSP output port of the sender of this RCSP stream.

  - RCSP input buffer: When receiving a stream via the RelayCaster Streaming Protocol (RCSP), specify the time in ms to cache incoming data before forwarding them. The default value is 100ms. In case of a connection with a high delay you should increase this value. Note: The RCSP input buffer must be smaller then the RCSP output buffer of the sender.

  - RCSP ping interval: When receiving a stream via the RelayCaster Streaming Protocol (RCSP), this value should be set to the round trip time (RTT) between client and server + 20%. The RTT can be meas-ured using the 'ping' command. The default value is 10ms. It is usually OK to specify values which are more than 20% above the RTT. How-ever, the RCSP ping interval must be less than the RCSP input buffer.

  - RCSP max new missing packets: When receiving a stream via the Re-layCaster Streaming Protocol (RCSP), this value specifies the maxi-mum number of new missing packets after which the RCSP protocol takes immediate action to prevent data loss. The default value is 20 packets. Lower numbers reduce the chance of loss of data at the cost of increased traffic.

- RCSP receive timeout: When receiving a stream via the RelayCaster Streaming Protocol (RCSP), this value specifies the time after which the RCSP protocol takes special action if it has not received any new data from the sender. The default value is 50ms. Lower numbers reduce the chance of loss of data at the cost of increased traffic.

- TTL (Optional): Specifies the time to live value for outgoing stream. The default value in web interface is 0 which means that RelayCaster automatically sets following values for TTL:

  1: If outgoing stream is a multicast stream.

  64: If outgoing stream is a unicast stream.

  Important note: Valid values, expect of 0, are 1-255. Please note that this value can have impact on how the streams are forwarded in your network environment. So you should be familiar with the meaning of these values before changing the default value.

In the advanced configuration dialog you can specify the following settings when using RCSP as output protocol:

- Dejitter Filter: Enable this when the stream has jitter issues. Make sure the receiving RCSP stream configuration also has this option set.

- RCSP output port: When sending a stream via the RelayCaster Streaming Protocol (RCSP), choose a free port that can be used by all RCSP receiving clients. Note: All clients that receive this stream have to configure their RCSP input port to the this value.

- RCSP output buffer: When sending a stream via the RelayCaster Streaming Protocol (RCSP), specify the time in ms to cache outgoing data for receiving clients. The default value is 100ms. In case of a connection with a high delay you should increase this value. Note: The RCSP input buffer of receiving clients must be smaller then the RCSP output buffer.

- Sender TTL (Optional): Specifies the time to live value for outgoing stream. The default value is 0 which uses a TTL value of 1 for multicast streams and a value of 64 for unicast streams.

  Important note: This value can have impact on how the streams are forwarded in your network environment. So you should be familiar with the meaning of this value before changing the default value.

Following is an example for setting the RCSP parameters of real-world setup consisting of two RelayCaster servers, RelayCaster A and RelayCaster B located on different continents of the world. RelayCaster A and B are connected with a lossy long-distance link using the public Internet infrastructure.

RelayCaster A receives a stream as Raw-UDP from the local area network it is connected to and sends the stream to RelayCaster B over the Internet using RCSP. RelayCaster B received the stream using RCSP and forwards it by using Raw-UDP to the local area network it is connected to.

▪ Within the web interface of RelayCaster A we create a new stream, and set RCSP as output protocol. Within the advanced configuration dialog, we set 12845 as RCSP output port. The RCSP output buffer is set to 1200 msec.

▪ Log in to RelayCaster B using ssh and run 'ping A' with A being the IP address of RelayCaster A. The value shown is between 60 and 80 msec. Therefore, the RCSP ping interval will be set to 120 msec.

▪ Within the web interface of RelayCaster B, we create a new stream, and set RCSP as input protocol. Within the advanced configuration dialog, we set the IP of RelayCaster A as RCSP sender address, and 12845 as RCSP input port. The RCSP input buffer has to be smaller than the output buffer by at least the value of the chosen RCSP ping interval of 120 msec. Therefore, we set the RCSP input buffer to 800 msec and the RCSP ping interval to 120 msec. Since the stream has a bandwidth of approximately 1 Mbps, RCSP max new missing packets is set to 400 which roughly corresponds to 400 msec of missing data. The value of RCSP receive timeout is set to 50% of the RCSP input buffer, i.e. 400 msec.

In the advanced configuration dialog you can specify the following settings when using SRT as input protocol:

▪ SRT Listener Latency(ms): Input buffer size in ms. If the caller has larger buffer configured that will be used instead (negotiated at connection setup).
▪ SRT Decryption Passphrase: The passphrase used for encryption. Leave empty if stream is not encrypted. The passphrase must be from 10 to 79 characters in length. The encrpytion strength will be negotiated automatically during connection setup.

In the advanced configuration dialog you can specify the following settings when using SRT as input protocol:

▪ Sender TTL: Set the Time-To-Live on IP-level. Set to 0 for system default
▪ SRT Caller Latency(ms): Output buffer size in ms. If the listener has larger buffer configured that will be used instead (negotiated at connection setup).
▪ SRT Overhead Bandwidth (%): Extra bandwidth that may be used after link failures to send queued packets.
▪ SRT Encryption Mode: The Encrpytion mode to use: 0=No-Encrpytion, 128=AES128, 256=AES256
▪ SRT Encryption Passphrase: The passphrase used for encryption. Leave empty if stream should not be encrypted. The passphrase must be from 10 to 79 characters in length.

o Click the **Create** button to create the stream and save the configuration. If the stream is created, it is listed in Section **Modify Streams** on the same page. You should see a green symbol in the status column if the stream is started and input data is available. If the stream could not be started or was stopped a red symbol will appear. If the RelayCaster recognizes a problem or the input data is not yet present, the symbol turns yellow. Please see Section 9.1 for more information. To update the status of the system and the symbol please reload the streams.php page (for example, by clicking on the 'Streams' tab).

Important note: If a stream from a specific input address should be send to multiple receivers, you can create additional streams with the same input address but different output addresses. In this case, the input protocol and the output protocol for all streams that use the same input address must be identical.

o Click the **Defaults** button to restore all default settings in this section.

Note: For convenience in case of the creation of several streams the tool **test_relaycaster** described in Section 19.1 is recommended.

7 Destroying or Stopping a Stream

- Access the web interface.

- Login with username and password.

- Select the configuration page **Streams**.

  o Select the wanted stream in the table **Modify Streams**.

  o To destroy the stream, click the **Destroy** button. The stream will be removed from the table.

  o To stop the stream, click the **Stop** button. You should see a red symbol in the status column. A stopped stream can be re-started by then clicking the **Start** button.

Note: For convenience in case of the deletion/stopping of several streams the tool **test_relaycaster** described in Section 19.1 is recommended.

8 Modifying a Stream

- Access the web interface.

- Login with username and password.

- Select the configuration page **Streams**.

Section **Modify Stream** lists available streams.

o Select the wanted stream in the table **Modify Streams**.

o If you want to change the stream identifier, enter the wanted values in the column **Stream name**

o If you want to change the stream source, enter the wanted values in the columns **Input address** and **input port**.

o If you want to change the streaming destination, enter the wanted values in the columns **Input address** and **input port**.

o If you want to change the advanced settings of the stream, click the image in the column **Adv** to open the advanced configuration dialog. Please refer to Section 6 for available settings:

o Click the **Modify** button to modify the stream and save the configuration. A green symbol signalizes that the stream could be modified whereas a red symbol will appear if this failed. If the RelayCaster recognizes a problem, the symbol turns yellow. Please see Section 9.1 for more information. To update the status of the system and the symbol please reload the streams.php page (for example, by clicking on the 'Streams' tab).

9 Displaying System Benchmarks and Status

- Access the web interface.

- Login with username and password.

- Select the configuration page **Streams**. To update the status of the system and the streams please reload the streams.php page (for example, by clicking on the 'Streams' tab) or wait some seconds (currently, after 10 seconds the status is updated).

  o This section provides the following status information, which are also visible on the display integrated into the device itself:

    Total Streams: Shows the amount of currently allocated RelayCaster streams that are send to clients.

    Bandwidth GbE: Shows the used incoming and outgoing network bandwidth in Mbps on network connector with label GbE.

    Bandwidth Mgmt: Shows the used incoming and outgoing network bandwidth in Mbps on network connector with label Mgmt.

    Disk usage /: Shows used disk space of root partition.

    Disk usage /home: Shows used disk space of /home partition.

    Disk usage /home/nmm/video: Shows used disk space of /home/nmm/video partition. Since the LCD display is limited to 16 characters the synonym 'ftp' is used as well.

    CPU load: Shows the current system load in percent.

    Memory usage: Shows the current memory usage in percent.

- If a warning or error is shown, you need to change the configuration of the system.

9.1 Stream Monitoring

The 'Modify Streams' section provides a status sign for each stream. To update the status of the system and the streams please reload the streams.php page (for example, by clicking on the 'Streams' tab) or wait some seconds (currently, after 10 seconds the status is updated). You should see a green symbol if the stream can be viewed. If the stream could not be started or was stopped a red symbol will appear. A yellow button indicates a problem that occurred during run-time. In this case you can get more information by selecting this button. The information in the appearing box indicates the following problems:

- Field 'Status' shows: No data is transmitted. In this case no data is received or could be sent. Please check the network configuration and ensure that the incoming stream is still available.

- Fields 'Total Errors, Total Events, Latest Errors and Latest Error Event at' show: Errors reported by the Continuity Counter. In this case the transport stream has discontinuities. Please check the incoming stream and ensure that there are no discontinuities in it.

- Field 'TS packet loss rate' shows a value of more than 1%. In this case the incoming stream is not correctly received and includes a lot of missing packets. Please check the network connection and ensure that system load of RelayCaster is not too high.

For RCSP streams also the following problems can occur:

- Field 'Forwarded packets' shows a value less than 99.9%. With RCSP no packets should be lost. However, this indicates that the used connection is too lossy.

- Field 'Received packets' shows a value of more than 110.0%. Too much duplicate packets were received because of too much retransmissions. This can be produced by Timeout NACK Packets or poor RCSP parameters.

- Field 'Sent packets : ..., lost %' shows a value of more than 10%. The packet loss rate strongly depends on the used connection. If it exceeds 10% the connection seems to be so bad that the provider should be informed.

- Field 'Unknown receivers' and the addresses of unknown receivers are shown. Unknown receivers mean addresses to whom no stream was created on this RCSP sender. This indicates that a RCSP receiver is not configured correctly, for example, that the 'RCSP sender address' was not set correctly.

The following issues do not lead to a yellow button but should be regarded as well wherefore a warning is shown:

- Field 'Timeout NACK packets' shows a value of more than 5%. Timeout NACKs should only be sent if for a longer period no data is received. If this happens the connection is very lossy or the RCSP parameters described in Section 6 are not set correctly (e.g. the receive timeout it too small).

- Field 'Urgent NACK packets' shows a value of more than 30%. Ideally, only regular NACKs should be sent. Otherwise, RCSP is not configured optimally (then please refer to the description in Section 6 to see how this is done).

The following values are averaged only over 10 seconds for short-term transmission information:

- Field 'Latest forwarded packets' shows what percentage of the packets could be forwarded to RCSP receiver.

- Field 'Latest received packets' shows the total number of received packets by the RCSP receiver including all retransmissions.

For SRT streams (input and output) the following information are shown:

- SRT Stream time (ms)' shows the runtime of the SRT stream in milliseconds.

- 'SRT Round Trip Time (ms)' shows the measured round trip time (ping time) in milliseconds.

For SRT input streams the following additional information are shown:

- 'SRT Receive Rate (MBit/s)' shows the stream bitrate at the receiver side.
- 'SRT Received Packets' shows the number of received packets since the start of the stream.
- 'SRT Received Loss Packets ' shows the number of lost packets since the start of the stream.
- 'SRT Receiver Drops' shows the number that the receiver had dropped because they were too old to be played.
- 'SRT Undecrypted Packets' Shows the number of undecrypted packets. It will increase if the passphrase is wrong.
- 'SRT TSBPD Delay (ms)' show the TimeStamp Based Packet Delivery delay in milliseconds. The is the sender-input to receiver-output delay of the stream.
- 'SRT Sent ACK total' shows the total number of sent acknowledgement packets to the sender.
- 'SRT Sent NAK total' shows the total number of sent negative acknowledgement packets to the sender.

For SRT output streams the following additional informations are shown:

- 'SRT Send Rate (MBit/s)' shows the stream bitrate at the sender side. It includes retransmissions and may be larger than the receiver side bitrate
- 'SRT Sent Packets' shows the number of sent packets since the start of the stream.
- 'SRT Sender Drops' shows the number of packets that have been dropped at the sender because they were too old to be sent.
- 'SRT Packets in flight' shows the estimated number of packets on the line between sender and receiver.
- 'SRT Received ACK total' shows the total number of received acknowledgement packets sent by the receiver.
- 'SRT Received NAK total' shows the total number of received negative acknowledgement packets sent by the receiver.
- 'SRT Retransmitted Packets' shows the number of packets that have been sent more than once.

10 Changing the Password

- Access the web interface.

- Login with username and password.

- Select the configuration page **Info**.

    o Enter a username and password and click the **Save** button

11 Changing Network Interfaces for Multicast Streams

The factory setting for outgoing multicast streams is GbE and for incoming multicast streams Mgmt.

Changing these settings in the RelayCaster works as follows:

- Access the web interface.

- Login with username and password.

- Select the configuration page **Info**.

    o Choose network devices for **Multicast Input** and **Multicast Output**.

      Note: The 'Default' option for multicast input will usually default to Mgmt, unless explicitly specified otherwise in the routing table of the system.

    o Click the **Save** button to apply the new settings.

These settings are stored in the config file.

12 Changing Network Interface IP Adresses

The IP Addresses of all network interface may be changed with the webui as follows:

- Access the web interface.
- Login with username and password.
- Select the configuration page **Settings**.
  - o **Hostname**: hostname of the machine (default value is 'RelayCaster').
  - o **Domain**: (default value is 'gmit-gmbh.de').
  - o **Mgmt IP**: (default value is '192.168.1.254').
  - o **Mgmt Network Mask**: (default value is '255.255.255.0').
  - o **Mgmt Gateway**: (default value is '192.168.1.1').
  - o **GbE IP**: (default value is '192.168.2.1').
  - o **GbE Network Mask**: (default value is '255.255.255.0').
  - o **GbE Gateway**: (default value is '0.0.0.0').
  - o **DNS** IP address of the DNS: (default value is '192.168.1.1').
  - o **NTP** IP address of the NTP Server: (default value is '192.168.1.5').

The Interfaces GbE-2 and GbE-3 are only shown if the RelayCaster has four network ports.

  - o **GbE-2 IP**: (default value is '192.168.3.1').
  - o **GbE-2 Network Mask**: (default value is '255.255.255.0').
  - o **GbE-2 Gateway**: (default value is '0.0.0.0').
  - o **GbE-3 IP**: (default value is '192.168.4.1').
  - o **GbE-3 Network Mask**: (default value is '255.255.255.0').
  - o **GbE-3 Gateway**: (default value is '0.0.0.0').

Click the **Save** button to apply the new settings. The dialog will freeze for about 5 seconds and when it closes, the machine will reboot with updated addresses. Please note that a reboot may take a couple of minutes.

13 Importing and Exporting the Configuration

Importing and exporting the configuration of the RelayCaster works as follows:

- Access the web interface.

- Login with username and password.

- Select the configuration page **Info**.

  o Click the **Export** or **Import** button and select a location and file name on the local host.

    Warning: don't import a configuration from a different (older or newer) 'RelayCaster' version.

    RelayCaster Lite (Software-Only) is a special version of RelayCaster that allows creating only one stream with up to 15 Mbps. If more than 15 Mbps is streamed, the RelayCaster Lite version can at any time stop to process the stream. If a configuration with more than one stream is imported, only the first stream is created.

Note: The tool **test_relaycaster** described in Section 19.1 can also be used to importing or exporting a configuration.

14 Resetting the Configuration

Resetting the configuration of the RelayCaster works as follows:

- Access the web interface.

- Login with username and password.

- Select the configuration page **Info**.

  o Click the **Reset** button and confirm the dialog with OK.

  o Wait at least 60 seconds before using the RelayCaster web interface again.

15 Getting NTP status information

Getting NTP status works as follows:

- Access the web interface.

- Login with username and password.

- Select the configuration page **Info**.

- Scroll down to header "NTP Status". If a NTP server is configured the line should show the following fields.

  o Remote=: The configured NTP server. If it is preceeded with '*' it is used synchronization

  o Stratum=: The stratum of the NTP server. A value of 1-3 is preferred here. higher numbers may result in lower time accuracy

  o Delay=: The measured one way delay for reaching the NTP server

  o Offset=: The measured time offset to the NTP reference time

  o Jitter=: The measured NTP packet arrival time jitter

  o Poll=: NTP poll interval in seconds

  o Reach=: Octal bitmask when NTP server was reached. Should show 0377, i.e. recent 8 NTP updates were successful

16 Accessing Logfiles

The log files are saved in the directory **/home/nmm/.nmm.**

You can download the log files as an .tgz archive using the web interface:

- Access the web interface.

- Login with username and password.

- Select the configuration page **Info**.

   o Press button 'Download all log files'.

      Important Note: This operation could take several minutes until the save dia-log appears for downloading all log files.

      Important Note: This operation can cause a high system load until the archive of all log files is created.

You can view the log files by using the web interface:

- Access the web interface .

- Login with username and password.

- Select the configuration page **Info**.

   o Access the last entries of the wanted log files by clicking on **last entries** or the full log file by clicking on **full log**.

17 Updating the RelayCaster

17.1 Updating the RelayCaster Connected to the Internet

Important Note: Before updating the RelayCaster ensure that you logout from the web interface of the RelayCaster as described in .

Updating the 'RelayCaster' works as follows:

- Login as user root by using a ssh client:

  ```
  ssh root@<IP_ADDRESS_OF_RELAYCASTER>
  (e.g. ssh root@192.168.1.254)
  ```

- Start the latest version of the script **nmm3_relaycaster_download.sh** to update the 'RelayCaster':

  ```
  sh /home/nmm/nmm3_relaycaster/bin/nmm3_relaycaster_download.sh
  ```

  Warning: This process removes the relaycaster configuration **~/.nmm/relaycaster.conf** and encodecaster configuration **~/.nmm/relaycaster_encoder.conf**

18 Downgrading the RelayCaster

Downgrading the 'RelayCaster' works as follows:

- Login as user root by using a ssh client:

  ```
  ssh root@<IP_ADDRESS_OF_RELAYCASTER>
  (e.g. ssh root@192.168.1.254)
  ```

- Stop the services as follows:

  ```
  sh /home/nmm/nmm3_relaycaster/bin/stop_all_relaycaster_services.sh
  ```

- Remove the system **link /home/nmm/nmm3_relaycaster** which points to the current release:

  ```
  rm /home/nmm/nmm3_relaycaster
  ```

- Remove the relaycaster configuration **/home/nmm/.nmm/relaycaster.conf:**

  ```
  rm /home/nmm/.nmm/relaycaster.conf
  ```

- Remove the encodecaster configuration **/home/nmm/.nmm/relaycaster_encoder.conf:**

  ```
  rm /home/nmm/.nmm/relaycaster_encoder.conf
  ```

- Remove the plug-in information **/home/nmm/.nmm/plugins.*:**

  ```
  rm /home/nmm/.nmm/plugins.*
  ```

- Create a new system link to a old release:

  ```
  ln -s /home/nmm/nmm3_relaycaster_<RELEASE_DATE> \
  /home/nmm/nmm3_relaycaster
  ```

- Hint: You can list all available releases as follows:

  ```
  ls -dl /home/nmm/nmm3_relaycaster_*_*
  ```

- Start the services as follows:

  ```
  sh /home/nmm/nmm3_relaycaster/bin/start_all_relaycaster_services.sh
  ```

19 Streaming Clients

19.1 Receiving Streams

To receive created streams that contain MPEG data streams (see Section 6) media players like VLC or mplayer can be used. The following sections describe the usage of the these applications.

19.1.1 VLC

- Download and install the VLC media player from http://www.videolan.org.

- Start the VLC media player (Linux: vlc, windows: vlc.exe).

- Select **Media -> Open Network** from the menu or press **Ctrl + N** and type in the following settings:
    - Protocol: UDP
    - Address: DESTINATION which has been used to create the stream (see Section 6) (e.g. 192.168.1.22)
    - Port: PORT which has been used to create the stream (see Section 6) (e.g. 12345)

- Click the "Play" button to receive the stream

Alternatively you can start vlc with command line arguments as follows:

```
vlc udp://@<DESTINATION>:<PORT>
(e.g. vlc udp://@192.168.1.22:12345)
```

If the received stream contains service information (SDT tables), VLC sometimes selects the wrong program. To override the selection choose the right program in the menu **Playback -> Program**. Alternatively you can choose the program by using command line   parameters:

vlc udp://@<DESTINATION>:<PORT> --program "<SERVICE_ID>"

In this case you have to provide the SERVICE_ID of the program.

Optionally, you can also create a playlist for easily selecting available streams, e.g. for performing channel-hopping. The following example shows and .xspf file containing two streams, named 'Channel 1' and 'Channel 2', available as multicast streams.

```
<?xml version="1.0" encoding="UTF-8"?>
<playlist version="1" xmlns=http://xspf.org/ns/0/
     xmlns:vlc="http://www.videolan.org/vlc/playlist/ns/0/">
  <title>Wiedergabeliste</title>
    <trackList>
        <track>
```

```
            <title>Channel 1</title>
            <location>udp://@239.1.1.1:12345</location>
            <extension application="http://www.video-
                          lan.org/vlc/playlist/0">
            <vlc:id>0</vlc:id>
            <vlc:option>udp-caching=300</vlc:option>
        </extension>
    </track>
    <track>
        <title>Channel 2</title>
        <location>udp://@239.1.1.2:12346</location>
        <extension application="http://www.video-
                          lan.org/vlc/playlist/0">
            <vlc:id>1</vlc:id>
            <vlc:option>udp-caching=300</vlc:option>
        </extension>
    </track>
</trackList>
<extension application="http://www.videolan.org/vlc/playlist/0">
    <vlc:item tid="0" />
    <vlc:item tid="1" />
</extension>
</playlist>
```

When opening this .xspf file, vlc allows for jumping from one stream to another by pressing the next/last track buttons. Please also make sure that deinterlacing is enabled.

19.1.2 mplayer

- Download and install mplayer from http://www.mplayerhq.hu.
- Start mplayer as follows:

```
Linux:

mplayer  udp://@<DESTINATION>:<PORT> -cache 1024 (e.g.  mplayer
udp://@192.168.1.22:12345 -cache 1024


Windows:

mplayer.exe udp://@<DESTINATION>:<PORT> -cache 1024
(e.g. mplayer.exe udp://@192.168.1.22:12345 -cache 1024
```

If the video contains artifacts increase the cache size from 1024 to a higher value.

20 Application Programming Interface

This section describes the RelayCaster application programming interface (API), which can be used by external applications to control the RelayCaster and query its status. The API provides a superset of all functionality which is exposed in the web interface.

NMM-based applications should use the NMM API, which is described in Section 18.1. Applications which are not using NMM can use the XML-RPC API, which is described in Section 18.2.

20.1 XML-RPC API

The XML-RPC interface is based on open standards, such as the HTTP protocol and the XML format, so it can be used by any application, such as a web application developed in PHP, a shell script, or a custom application which does not use NMM. Furthermore, our integrated RPC server supports encrypted connections using SSL.

21 Tools

This section describes RelayCaster tools, which can be used to control the RelayCaster and query its status using the RelayCaster API (see Section 18.1 for details).

21.1 test_relaycaster

The tool `test_relaycaster` is included in your RelayCaster release and can be used to efficiently set up and control streams. It can be started as follows.

```
ssh nmm@<IP of RelayCaster server>
cd /home/nmm/nmm3_relaycaster/bin/
./wrapper.sh test_relaycaster
```

For detailed usage information, run the application as follows:

```
./wrapper.sh test_relaycaster -h
```

An important use case is explained as an example how to use the tool: The creation of several streams. In the following, it is assumed that your RelayCaster system has the IP address 192.168.1.10 and two incoming streams to ports 12345 and 12346 are available, which are to be forwarded to IP address 192.168.1.11 and ports 23456 and 23457.

```
ssh nmm@192.168.1.10
cd /home/nmm/nmm3_relaycaster/bin/
./wrapper.sh test_relaycaster -H 192.168.1.10
```

At that point the tool will show a list of available commands. To create several streams with consecutive port numbers, the command `tryCreateStreams` can be used. The command needs to be entered and confirmed by pressing the 'Enter' key. The tool will ask you for needed settings and provides default values in square brackets. Please enter the required settings or leave the fields empty to use the default and press the 'Enter' key again.

```
create stream for benchmark:
 streaming source (address) [127.0.0.1]: 192.168.1.10
 streaming source (port) [12345]: 12345
 input protocol (0=RAWUDP, 1=RTP, 2=RCSP) [0]: 0
 streaming destination [192.168.1.10]: 192.168.1.11
 streaming destination (port) [12345]: 23456
 output protocol (0=RAWUDP, 1=RTP, 2=RCSP) [0]: 0
 number of streams [1]: 2
```

As 'streaming source' the IP address of your RelayCaster or a multicast address has to be entered, plus the port for receiving the stream. Please ensure that at the chosen

address and port a stream is available. The 'input protocol' and 'output protocol' can be chosen between Raw-UDP, RTP and RelayCaster Streaming Protocol (RCSP) (only if purchased). The parameters for 'streaming destination' specify the destination IP address and port (either unicast or multicast). When using the command `tryCreateStreams`, you are able to specify how many streams are to be created. If more than one stream is to be created, the used port numbers for incoming and outgoing streams will automatically be increased. Be careful when using this command for multicast streams: We recommend to always use a different multicast address and different port for each stream. In this example, two UDP streams to IP address 192.168.1.11 ports 23456 and 23457 will be created. If the streams with this settings could be created successfully the following output will be printed:

```
creating stream (source: 192.168.1.10:12345,
    destination: 192.168.1.11:23456)
created stream with stream ID 1 creating stream (source:
192.168.1.10:12346,
    destination: 192.168.1.11:23457)
created stream with stream ID 2
```

The `test_relaycaster` tool can also be used with scriptable user interaction. For detailed usage information, run the tool as follows (please notice that you need to provide '-' three times).

```
./wrapper.sh test_relaycaster ---help
```