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List of abbreviations

CLI	Command Line Interface
CRS	Customer Requirement Specification
GUI	Graphical User Interface
IGMP	Internet Group Management Protocol
MC	Multicast
MLD	Multicast Listener Discovery
MMRP	Multiple Multicast Registration Protocol
SRS	System Requirement Specification
UDP	User Datagram Protocol

1. System requirements

Operating System:
- Microsoft Windows XP (SP2) / Vista / Windows 7
- Linux 2.6 or newer

Hardware requirements:
- Standard x86- or x64-PC
- 256 MB available Memory
- 50 MB free Space
- Ethernet-Interface 100BASE-TX and/or 1000BASE-T

Software requirements:
- Java SE 1.6 Runtime or newer
- Pcap- or WinPcap-Library
- Required Drivers for Network interface

Additional Requirements:
- **Linux**: MultiCastor has to be executed as user „root"
- **Windows**: MultiCastor has to be executed as administrator or WinPcap must be installed as a service

2. Installation guide

Multicastor is shipped as a Zip-File. The following steps are required to complete the installation:

1. Extract the Zip-Archive, that includes the „Multicastor.jar" File into a Directory with write access
2. Start the program either with a double-click or by using the command line

3. Overview User interface

The Graphical User Interface is split into seven segments:

1. Menu bar
2. Information-Panel
3. Graph/Console
4. Configuration-Panel
5. Button-Bar
6. Table
7. Status bar

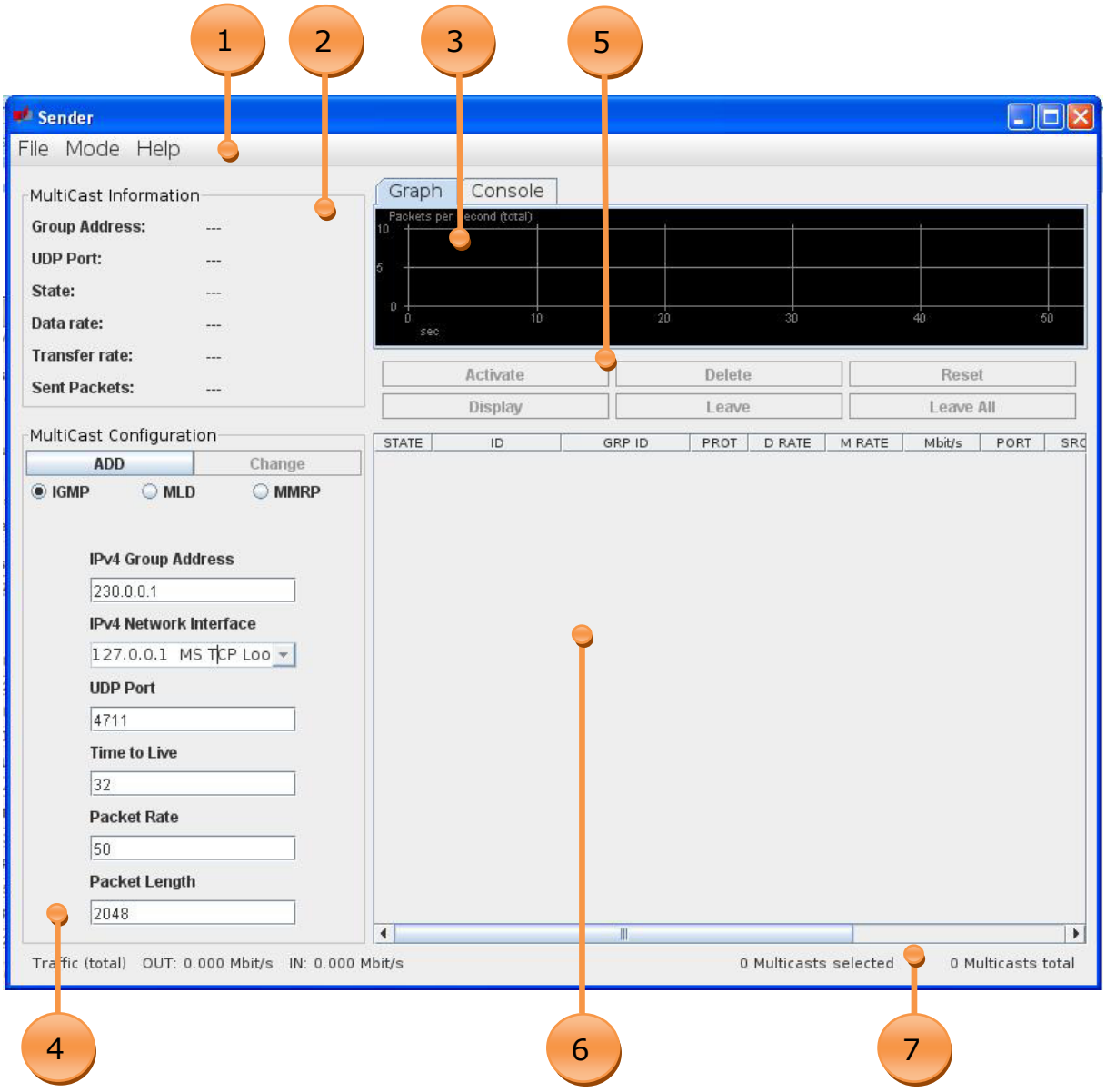


Figure 1: Graphical User Interface

Menu bar

The Menu bar has the following three entries: *File, Modus, Help*.
In menu item ***File*** *are* the following entries:

Menu entry	Description
Save Configuration	Save Multicasts into a XML-File
Load Configuration	Load Multicasts from XML-File
Recently Used Configuration Files	Load Multicasts from recently used XML Files
Exit	Close Multicastor

Table 1: Menu File

With the menu item ***Modus*** is decided whether the Multicastor instance is used as a sender or receiver. Here are the following entries:

Menu entry	Description
Sender	Set Modus to „Sender"
Receiver	Set Modus to „Receiver"

Table 2: Menu Modus

Information and support will be found at the menu item ***Help***.

Menu entry	Description
Manual	Open Manual (PDF-File)
Language	Select the Language of Multicastor (English or German)
About	Display Information about Multicastor

Table 3: Menu Help

Information-Panel

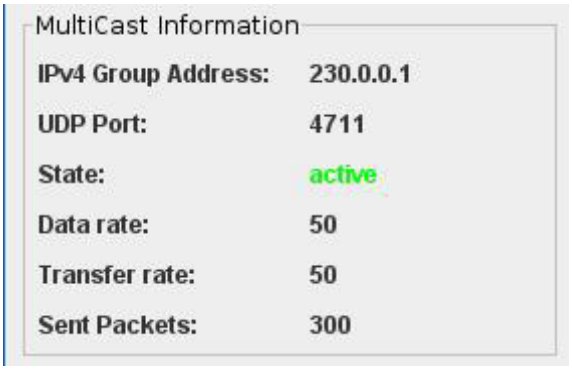


Figure 2: Information-Panel for activated sending Multicast

The Information-Panel is placed in the upper left corner. It displays information to the Multicast, which is currently selected in the table.
When multiple Entries are selected the Information-Panel will show details about the first Multicast in the selection.
The following details about a Multicast will be displayed:

Name	Description
(IPv4|IPv6) Group Adresse	IP-Address of the Multicast-Group
Group MAC Address	Mac Address of the Multicast-Group
UDP Port	Port number
Status	Status of Multicast (active, inactive).
Data rate	Expected packet rate in packets/second
Transfer rate	Measured packet rate in packets/second
(Send|Received) Packets	Counter for received or send packets

Table 4: Information-Panel

Graph/Console

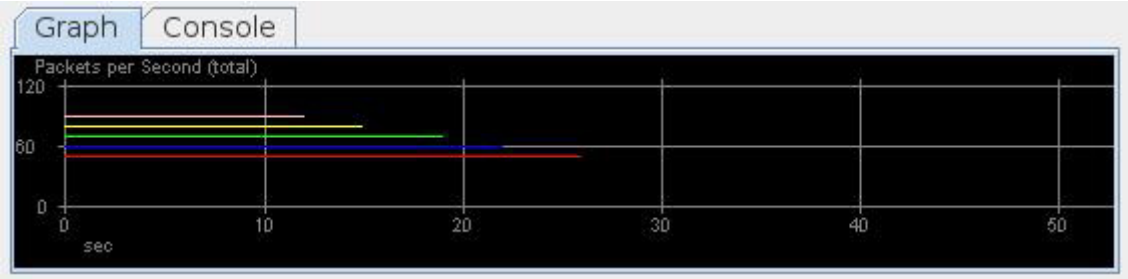


Figure 3: Graph for 5 activated Sender-Streams

The Graph and the Console are placed in the upper right space. By using the tabs Graph or Console the user can switch between seeing the Graph or seeing the Console.
In Modus Receiver the Graph has three possible XXX which can be selected by using the Radio buttons:

Name	Description
Jitter	Deviation of packet rate
Lost Packets	Lost packets
Measured Packets	Received packets

Table 5: Display options Graph in Modus Receiver

The Console displays all Log messages. For further Information about displaying Multicasts in the Graph please read *Display Multicasts*.

Configuration-Panel

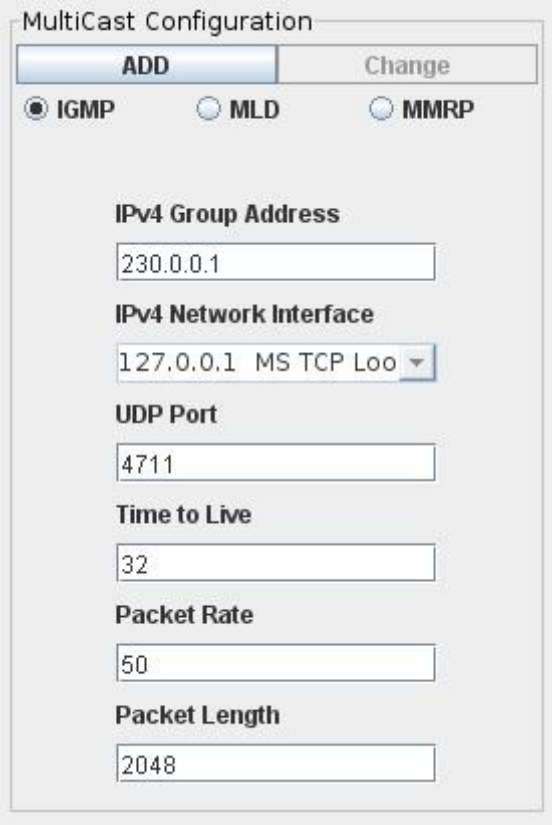
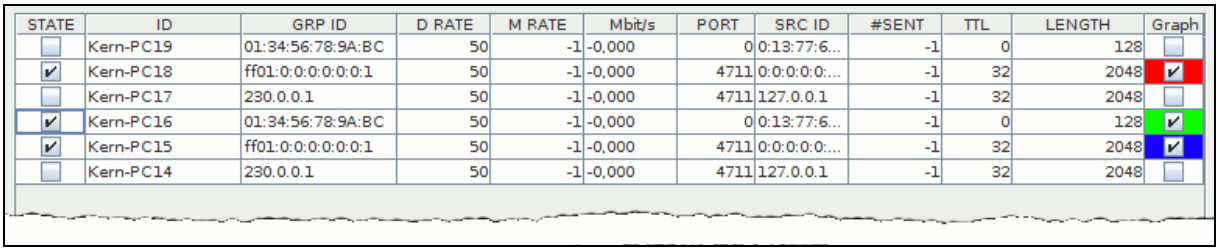


Figure 4: Configuration-Panel for Sender IGMP

The Configuration panel is placed left to the table. Depending on the Modus it is possible to add and edit Multicasts.
The Button „Add" will add the configured Multicast to the table.
When a Multicast is selected in the table, all its details are displayed in the Configuration panel. It is possible to change these values and to apply the changes by clicking the "Change" Button.
The Radio buttons „**IGMP**", „**MLD**" and „**MMRP**" specify the Protocol of a Multicast. When a Radio button is clicked all Text fields will be filled with Default values.
For specific information about configuring a sender please read Configure Sender and for a receiver Configure Receiver.

Table



STATE	ID	GRP ID	D RATE	M RATE	Mbit/s	PORT	SRC ID	#SENT	TTL	LENGTH	Graph
☐	Kern-PC19	01:34:56:78:9A:BC	50	-1	-0,000	0	0:13:77:6...	-1	0	128	☐
☑	Kern-PC18	ff01:0:0:0:0:0:0:1	50	-1	-0,000	4711	0:0:0:0:0:...	-1	32	2048	☑
☐	Kern-PC17	230.0.0.1	50	-1	-0,000	4711	127.0.0.1	-1	32	2048	☐
☑	Kern-PC16	01:34:56:78:9A:BC	50	-1	-0,000	0	0:13:77:6...	-1	0	128	☑
☑	Kern-PC15	ff01:0:0:0:0:0:0:1	50	-1	-0,000	4711	0:0:0:0:0:...	-1	32	2048	☑
☐	Kern-PC14	230.0.0.1	50	-1	-0,000	4711	127.0.0.1	-1	32	2048	☐

Figure 5: Table displaying Multicasts

The table is placed in the center of Multicastor. In the table all Multicasts are displayed and can be configured
The table has the following columns:

Table column	Description
STATE	State of the Multicast
ID	Multicast Identifier
GRP IP	Group IP-Address
D RATE	Packet Rate
M RATE	Transfer Rate
Mbits/s	Traffic OUT
PORT	UDP Port number of the Multicast
SRC IP	Source IP-Address (Interface)
#SENT	Send or received packets
TTL	Time to Life of the Multicast
LENGTH	Packet length of the Multicast
Graph	State of the graph

Table 6: Table columns

To sort the table by a specific column, click on the Column header. First the order is ascending, with another click the order switches to descending.

Button-Bar

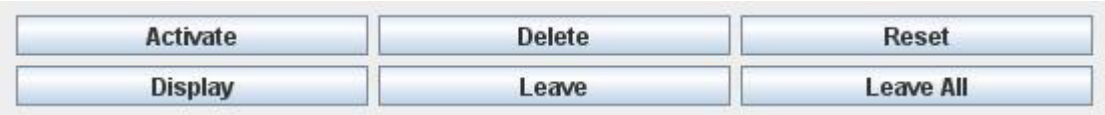


Figure 6: Button-Bar

The button bar is used to control Multicasts. To enable the buttons at least one Multicast has to be selected in the table.

Button	Description
Activate / Deactivate	activate or deactivate
Display	Show or hide the Graph
Delete	Delete selected Multicast(s)
Leave	Send the MMRP-Event „Lv"
Reset	Reset a Multicast
Leave All	Send the MMRP-Event „LeaveAll"

Table 7: Buttons

Status bar

The status bar is placed on the bottom of Multicastor. On the left side of the status bar are information about the current data traffic. On the right side the number of selected and total Multicasts is displayed

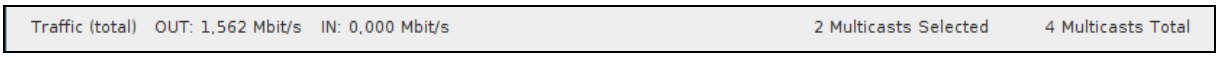


Figure 7: Status bar

4. Configure Sender

After Multicastor is started the modus can be switched to „Sender", if this hasn't been done by default. To switch form Receiver to Sender use the Menu „Modus" and then click „Sender".

To configure or add a Multicast, use the Configuration Panel left to the table. In the Configuration Panel you can switch between the protocols IGMP, MLD and MMRP. Depending on the selected protocol the required input masks appear. The following table lists all valid data areas for all input fields:

Text field	Protocol	Valid input values
IPv4 Group Address	IGMP	Valid IPv4-Addressed, Address range: 224.0.0.0 to 239.255.255.255
IPv6 Group Address	MLD	Valid IPv6-Addresses, Address range: FF00::/8
Group MAC Address	MMRP	01:00:00:00:00:00 to 01:FF:FF:FF:FF:FF, **not** 01:80:C2:00:00:00 to 01:80:C2:FF:FF:FF and 01:00:5E:00:00:01
(IPv4/IPv6) Network Interface	IGMP / MLD / MMRP	Drop-Down menu with valid network interfaces
UDP Port	IGMP / MLD	Integer von 1 to 65.535
Time to Live	IGMP / MLD	Integer von 1 to 32
Packet Rate	IGMP / MLD / MMRP	Integer von 1 to 65.535
Packet Length	IGMP / MLD MMRP	Integer von 52 to 65.507 Integer von 52 to 1.500

Table 8: Configure Sender

The packet rate is hardware specific. That means high packet rates aren't supported by all Network interfaces.

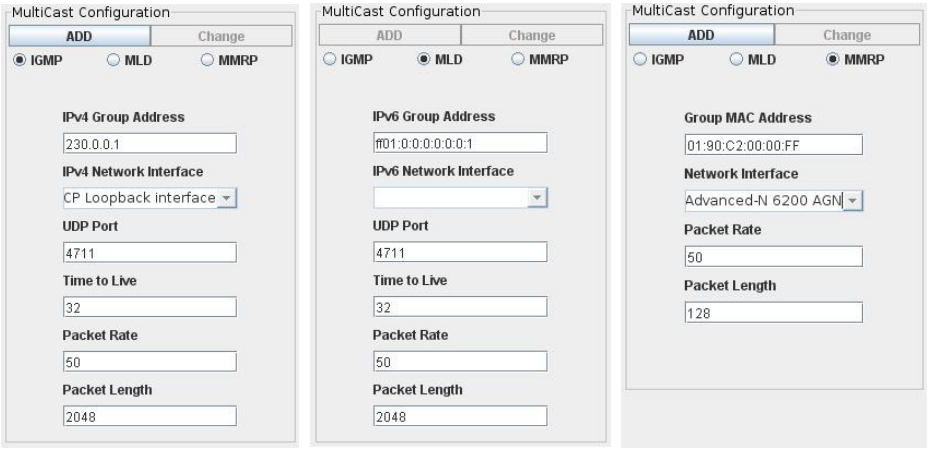


Figure 8: Configuration Sender

5. Configure Receiver

Configuring a receiver works analog to configuring a sender. When Multicastor is started the Mode should be switched to "Receiver", if not already happened. This is done by clicking "Mode" –> "Receiver". At the lower left corner the input mask for adding and editing Multicasts is placed.

Here it's possible to choose between the protocols IGMP, MLD and MMRP. Depending on the selected protocol all required input fields appear.

The following table shows all valid input ranges, listed for every input field:

Text field	Protocol	Valid input values
IPv4 Group Address	IGMP	Valid IPv4-Addressed, Address range: 224.0.0.0 to 239.255.255.255
IPv6 Group Address	MLD	Valid IPv6-Addresses, Address range: FF00::/8
Group MAC Address	MMRP	01:00:00:00:00:00 to 01:FF:FF:FF:FF:FF, **not** 01:80:C2:00:00:00 to 01:80:C2:FF:FF:FF and 01:00:5E:00:00:01
UDP Port	IGMP / MLD	Integer from 1 to 65.535
Network Interface	MMRP	Drop-Down menu with valid network interfaces
JoinMT Timer	MMRP	-1: no MMRP-Interaction by the added receiver 0: at creation a JoinMt Event is send and when a Lv/Mt-Event is received a JoinMt Event will be send. 1 to 65535: see entry 0 and a JoinMt-Event in the specified period (ms)

Table 9: Receiver configuration

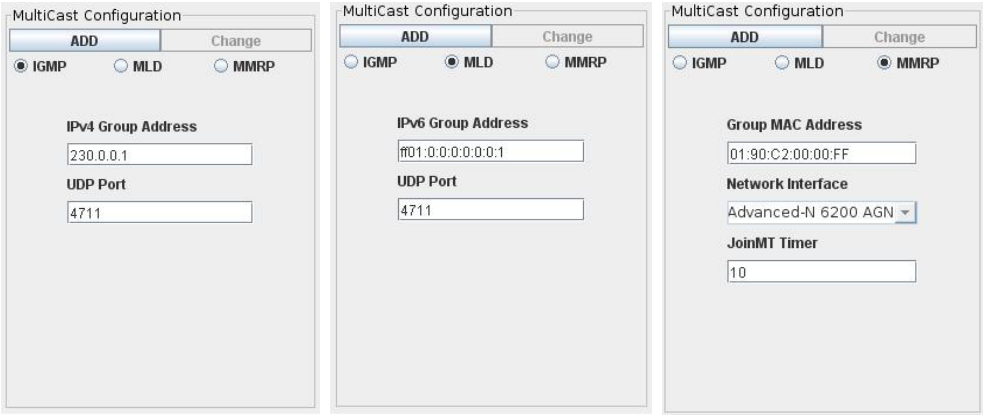
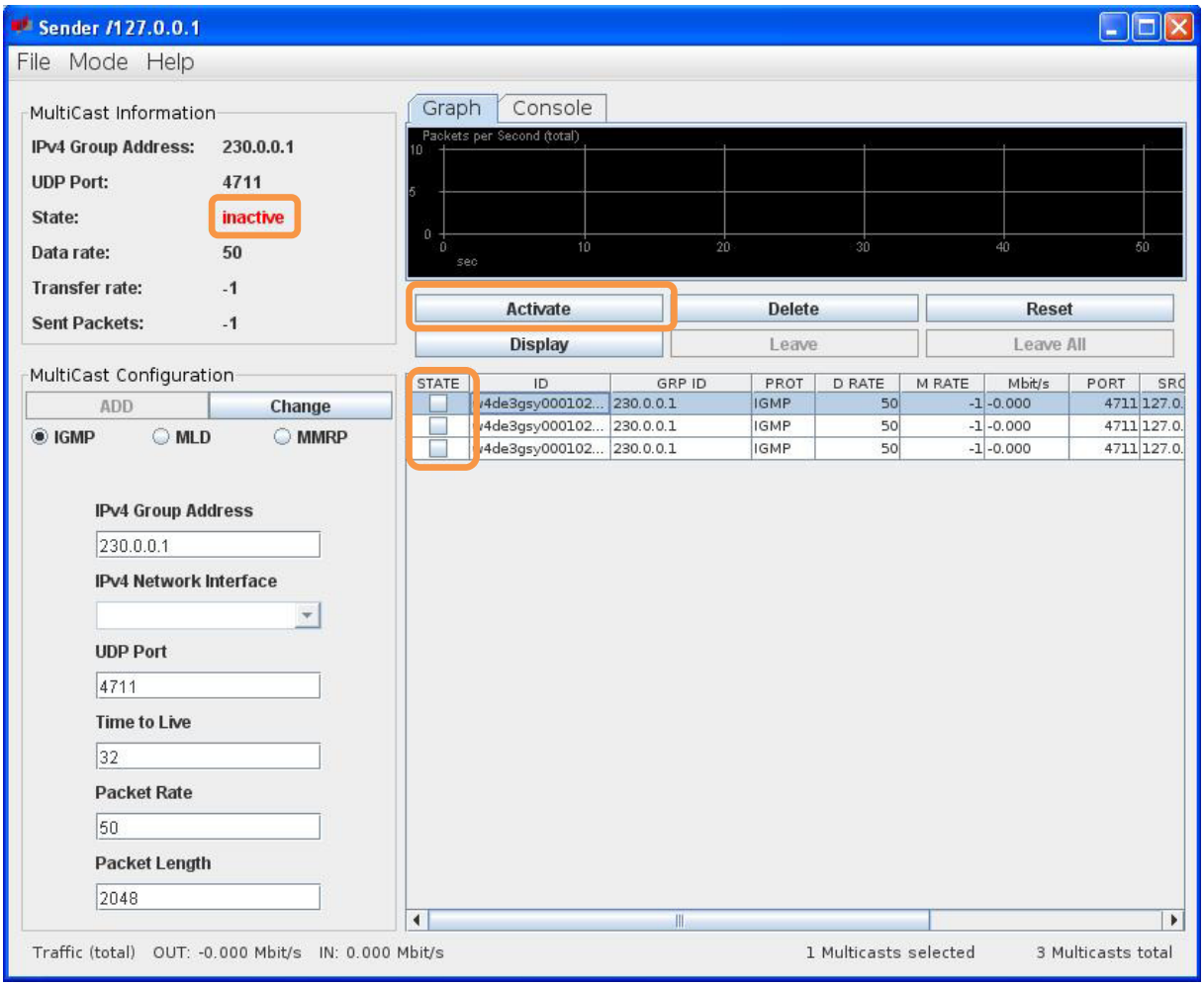


Figure 9: Configuration Receiver

6. Manage Multicasts

Start and stop Multicasts

To start or stop the Multicasts which should be started/stopped need to be selected in the table. The selected Multicasts will be started by clicking the "Activate" button and stopped by clicking "Deactivate".
If multiple Multicasts are selected and some are already active, then the button "Activate" will start all deactivated Multicasts in the selection.
When a Multicast is deactivated the corresponding graph diapers, assuming it wasn't hidden before.
Instead of using the buttons it is also possible to start or stop one or multiple Multicasts by using the checkbox in the table column „State".



Display Multicasts

Multicasts can be displayed as a graph. Multicastor is able to show 5 different graphs at the same time.
All Multicasts that are displayed are identified by the same color in the table. A Multicast can be displayed by clicking the button "Display" or by using the check box in the table column "Graph". When a Multicast is displayed, it's possible to hide the graph by clicking the button "Hide" or unchecking the check box.

Group Multicasts:

To create a group of Multicasts the following steps are necessary:

1. Select multiple Multicasts
2. Context menu (right click) -> „Group"
   or click the button „Display"

Multicasts in the same group can be identified by the same color in the table column „Graph".
A group is a combination of multiple Multicasts, but it has only effects on the graph, which then will show the combined values of all Multicasts in the group.

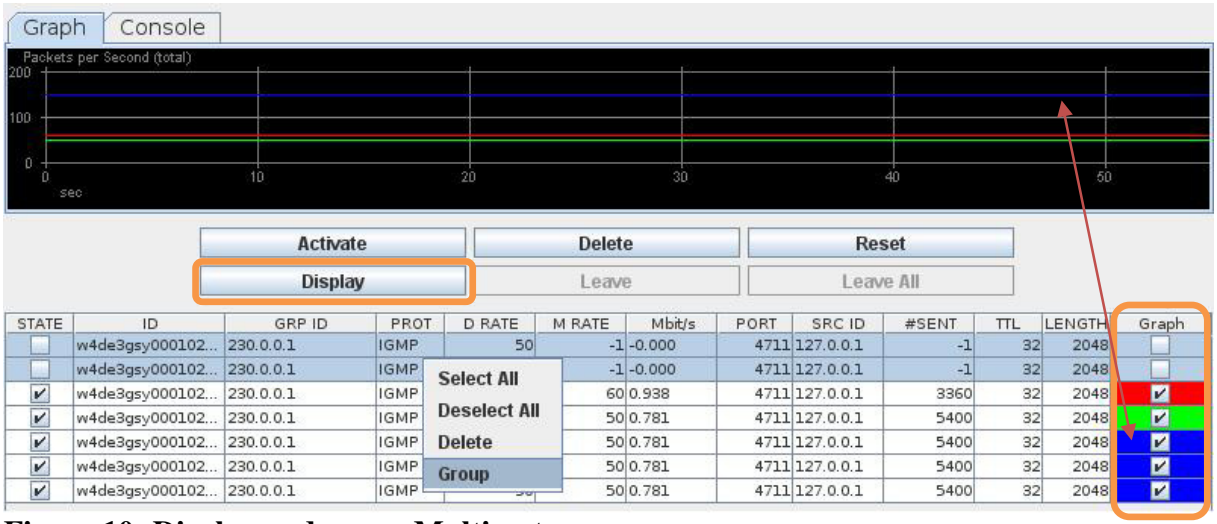


Figure 10: Display and group Multicasts

Reset Multicasts

Multicasts can be reset by using the Button „Reset" in the Button bar. Every Multicast has a Counter, which counts all send/received packets.

Reset will set this counter to zero.

Steps:

1. Select Multicasts
2. Click button „Reset"

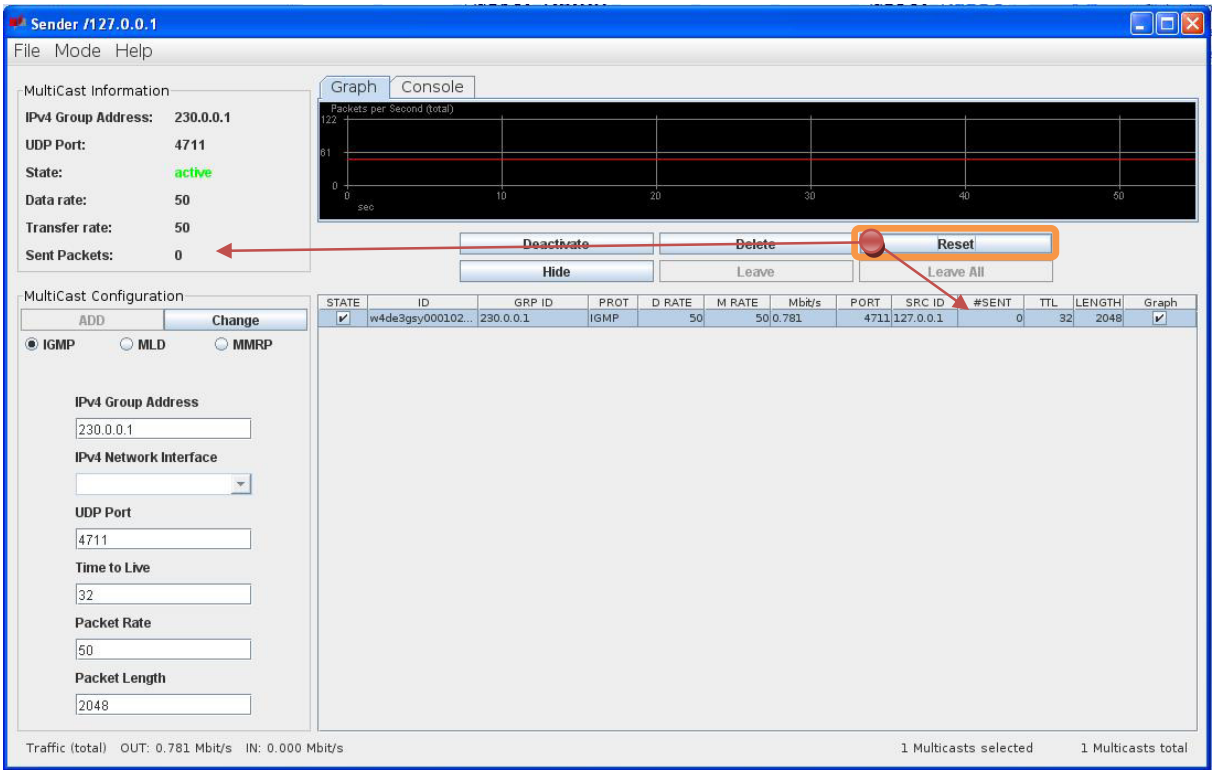


Figure 11: Reset Multicast

7. Configuration

Save Configuration

Current configurations can be saved in a XML-File. By clicking *File* -> *Save Configuration* a Save-Dialog will show. In the dialog a directory and filename can be set. By confirming the dialog the configuration file will be created and all Multicasts are saved.

The saved state is restored later by loading this configuration file.

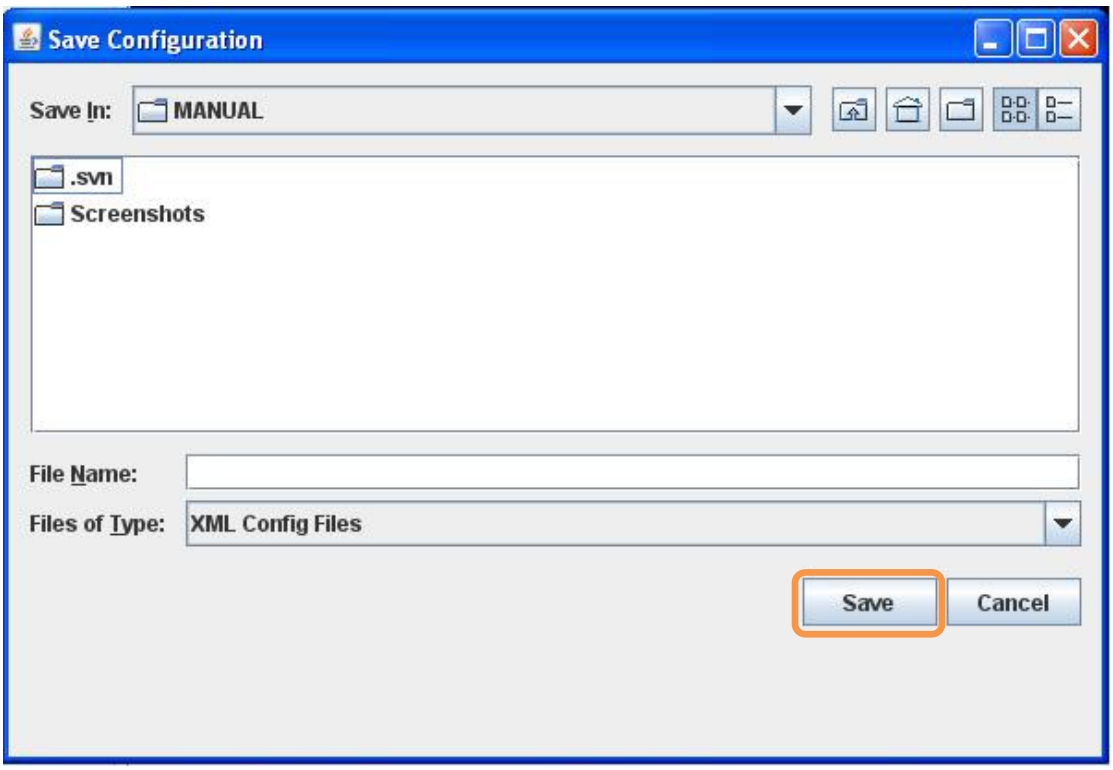


Figure 12: Save configuration

Load Configuration

Loading a configuration file is accomplished via the menu *File -> Load Configuration*. A dialog for loading the file will show up. In this dialog the configuration file can be selected.
This dialog offers the option to load the configuration file incremental. When loading a configuration file incremental the Multicasts from the file will be added to existing Multicasts. Otherwise all existing Multicasts will be deleted first.

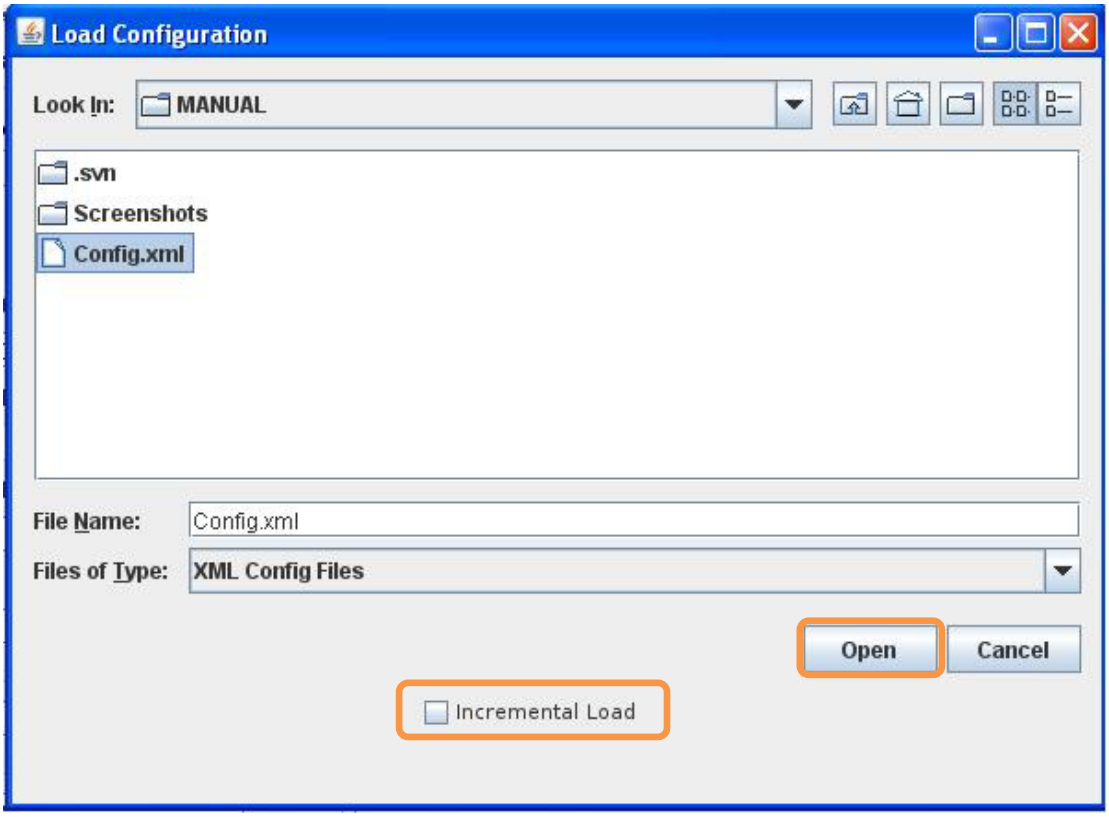


Figure 13: Load configuration

Edit default values

When configuring a new Multicast all text fields are filled with default values initially. These default values are stored in the configuration file *DefaultMulticastData.xml*. This file is placed in the installation directory and has the following structure:

```
<?xml version="1.0"?>
<MultiCastor date="Thu Feb 02 19:25:17 CET 2012">
	<default>
		<Multicast protocolType="IGMP">
			<active>false</active>
			<groupIp>230.0.0.1</groupIp>
			<udpPort>4711</udpPort>
			<packetLength>2048</packetLength>
			<ttl>32</ttl>
			<packetRateDesired>50</packetRateDesired>
		</Multicast>
		<Multicast protocolType="MMRP">
			<active>false</active>
			<macGroupId>12:34:56:78:9A:BC</macGroupId>
			<packetLength>128</packetLength>
			<packetRateDesired>50</packetRateDesired>
		</Multicast>
		<Multicast protocolType="MLD">
			<active>false</active>
			<groupIp>FF01:0:0:0:0:0:0:1</groupIp>
			<udpPort>4711</udpPort>
			<packetLength>2048</packetLength>
			<ttl>32</ttl>
			<packetRateDesired>50</packetRateDesired>
		</Multicast>
	</default>
</MultiCastor>
```

To customize the default values the old values have to be replaced manually. To complete the change Multicastor has to be restarted.

8. Use Multicastor from command line

Multicastor can also be used without a graphical user interface by using the command line. To start Multicastor without graphical user interface the command *„java –jar MultiCastor.jar*" has to be executed with one of the following attributes:

Attribute	Description
-h	Display a usage message
-g [s|r] <Config-File>	Start Multicastor with a configuration file as sender (s) or receiver (r)
-s <MultiCast>	Start Multicastor with one specified sender Mulitcast running **Example for IGMP:** $> java –jar MultiCastor.jar -s 230.0.0.1 127.0.0.1 4711 2048 32 50
-r <MultiCast>	Start Multicastor with one specified receiver Multicast running **Example for IGMP:** $> java –jar MultiCastor.jar -r 127.0.0.1 4711

Table 10: Command line parameters

<Config-File> Path to configuration file

<MultiCast> Multicast stream

A Multicast is based on the following attributes:

- GroupAddress
- SourceAddress (Interface)
- UDP Port
- Packet Length
- TTL
- Packet Rate

The running Multicastor is closed by using the key combination *Ctrl+C*.

9. History

Multicastor has been developed as a project in the course "Software Engineering" at Baden Wuerttemberg Cooperative State University (DHBW) Stuttgart, under the direction of lecturers Markus Rentschler and Andreas Stuckert.

The following students where responsible for development:

MultiCastor 1.0

Becker, Daniel
(Leading Engineer)

Beutel, Johannes
(Engineer/Tester)

Gerz, Daniela
(Documentation)

Lüder, Thomas
(Product Manager)

Müller, Jannik
(Engineer/Tester)

Wagener, Bastian
(Project Leader)

MultiCastor 2.0

Eisenhofer, Manuel
(Engineer)

Kern, Michael
(Engineer)

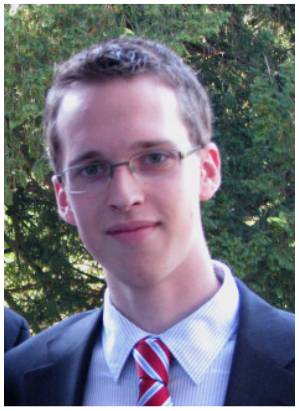
Michelchen, Tobias
(Engineer)

Scharton, Roman

(Project Leader,
MMRP-Expert)

Schumann, Pascal

(Engineer, Tester)



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11. Glossary

GUI Graphical User Interface

IGMP Internet Group Management Protocol -
IGMP is based on the IP-Protocol and allows IPv4 Multicasts.

IP Internet Protocol – is a widely used network protocol and the foundation of the internet.

MLD Multicast Listener Discovery – MLD is based on the IP-Protocol and a similar operating mode as IGMP. MLD allows IPv6-Multicasting.

MMRP Multiple MAC Registration Protocol – MMRP is a Layer 2 protocol for registering MAC-Addresses on multiple switches

Multicast Transmission from one point to a group (multipoint connection). Packets can be transmitted to multiple receivers at the same time or to a closed group of recipients without doubling the bandwidth at the sender by each receiver.
Packet duplication is done at every router/switch on the route to the receivers. To receiver a Multicast, a receiver needs to register itself at the sender.

Port The Port is part of an address, which associates a data segment to a network protocol. Also a port is a process-specific software, that provides a communication endpoint.

TTL Time-to-Live – The name of a Header field of the internet protocol, that prevents routers from forwarding undeliverable packets.

UDP User Datagram Protocol – is a simple, connectionless network protocol. UDP transmits packets without providing reliability, ordering or data integrity.
That means there is no certainty weather a send packet was received, nor that the packets have been received in the sending order. Therefor applications that use UDP have to be immune to packet loss or unordered packets.