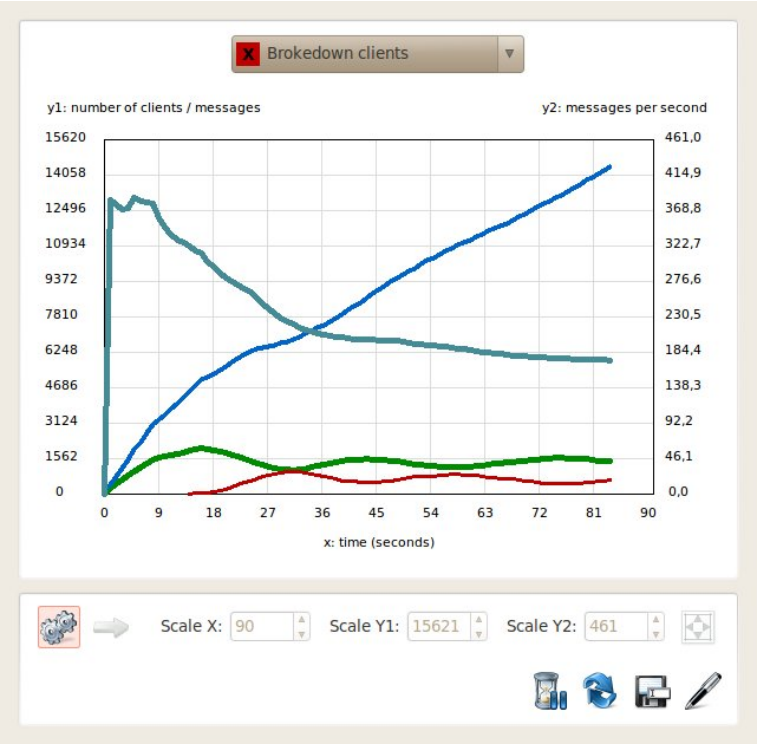

MANUAL

mbgprotosim

Meinberg Protocol Simulation

4th April 2012

Meinberg Radio Clocks GmbH & Co. KG

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1 Impressum

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2 Introduction

Congratulations on your purchase of Meinberg Protocol Simulation!

This manual explains the main functions of the simulation and is intended to make it easier for you to get started. The simulation software affords the test of NTP timeservers, NTP clients, PTP timeservers, PTP switches and many other devices, which are neccessary for the time synchronization in networks. The devices can, amongst other things, be tested on their general function regarding the appropriate protocol, response times, packet loss rates, their reaction on failures of other devices or the handling with increased loads. With an adequately equipped system, you can for example simulate about 10000 NTP clients simultaneously.

The following modes are provided by the software:

NTP
```
NTP Clients (IPv4, IPv6)
NTP Server (IPv4, IPv6)
```

PTPv1 (IEEE 1588-2002)
```
Multicast Slaves (IPv4)
```

PTPv2 (IEEE 1588-2008)
```
Unicast Slaves (IPv4, IPv6)
Unicast Masters (IPv4, IPv6)
Multicast Slaves (IEEE802.1/Ethernet Layer 2, IPv4, IPv6)
Multicast Masters (IEEE802.1/Ethernet Layer 2, IPv4, IPv6)
```

In the beginning of this manual, in a short quick start guide, it is explained how to start the simulation. Subsequently, the composition of the main dialog and the fundamental functions are described in detail. A description of the group configuration shall help you to understand the different parameters when adding or editing a client group. In the end, the functions during the runtime of a simulation and the graph window are illustrated.

If you notice any bugs or errors during the handling with Meinberg Protocol Simulation, please help us to correct them by sending a mail to support@meinberg.de. Thank you for your help and have fun using the protocol simulation!

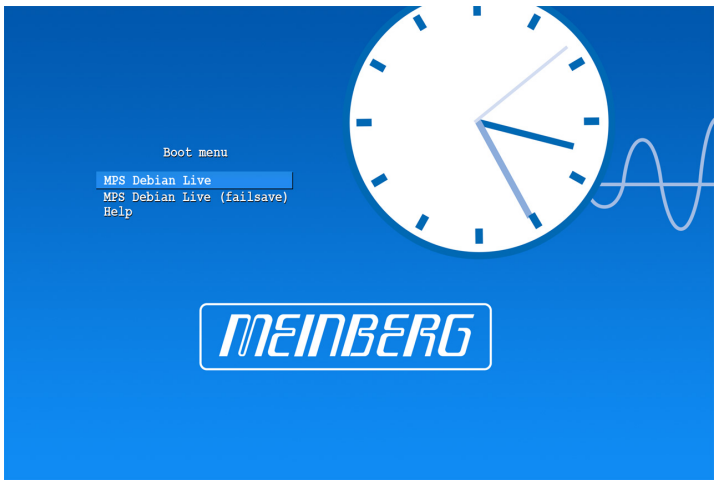
Minimum requirements:
1.6 GHz 64-bit CPU (dual core)
4GB RAM
Min. 1 compatible network interface card (e.g. Intel EtherExpress 1000, Realtek 8169)
Compatible graphics adapter & monitor (Resolution min: 1280x1024, recommended: 1920x1080)

3 Quick start quide

The simulation is delivered on a bootable USB stick with Debian 6 AMD64 live-system. This allows you to run the software without any installation efforts on any 64bit system. With this guide, you should manage to start the simulation without any problems.

Step 1 - USB boot:
At first, plug in the USB stick "MPS Live" in a USB port of your system and reboot. Enter your systems BIOS setup and make sure, that USB boot is enabled and that the USB stick is on top of your boot sequence.

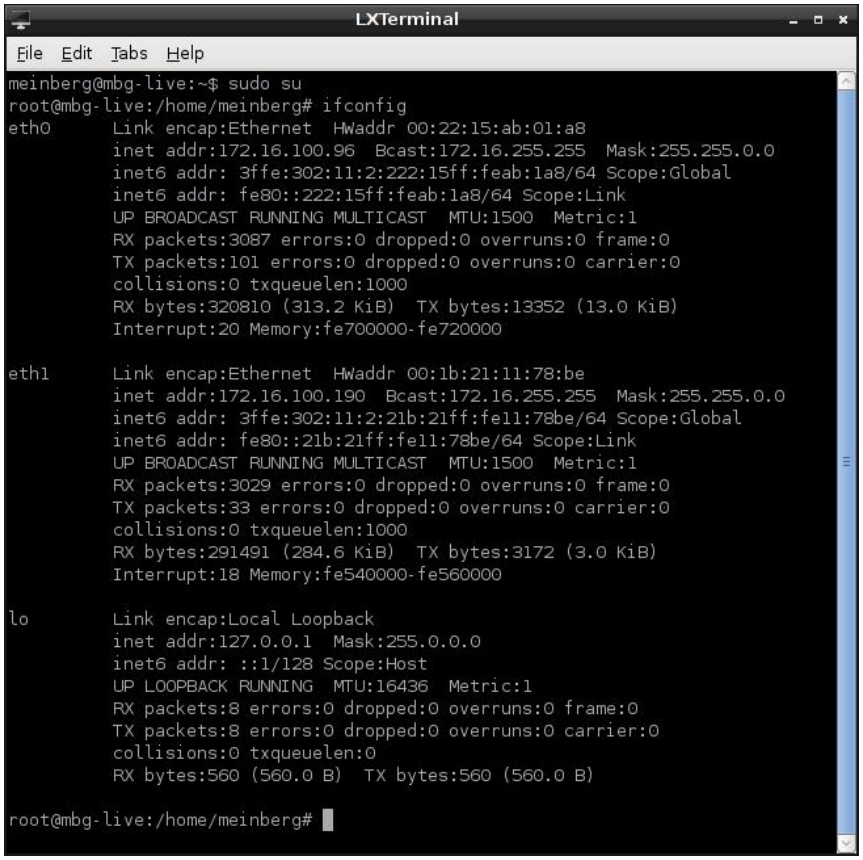
Step 2 - Choose boot menu entry
If your boot sequence is configured correctly, the following boot menu should appear on your screen:



Please choose the entry "MPS Debian Live" and submit by pressing Enter.

Step 3 - Login:
After a short while of booting, you should automatically be logged in as user "meinberg". If you are not logged in automatically, please login as user "meinberg" with password "live". The following desktop should appear on your screen:

Step 4 - Network configuration:
To start a simulation, you first have to configure your network interface(s). If your network has a DHCP server available, your network interfaces should receive an IP address automatically and the configuration will be ready at first startup. To check your configuration, open a LXTerminal by double clicking the appropriate desktop symbol and type in the commands: "sudo su", "ifconfig". If your network interfaces have automatically been configured correctly, you should see an IPv4 address for your interface(s) (i.e. eth0/eth1). Otherwise, you can find out how to configure a static IP address for your network interface(s) in the next chapter. A correct configuration could look like this:



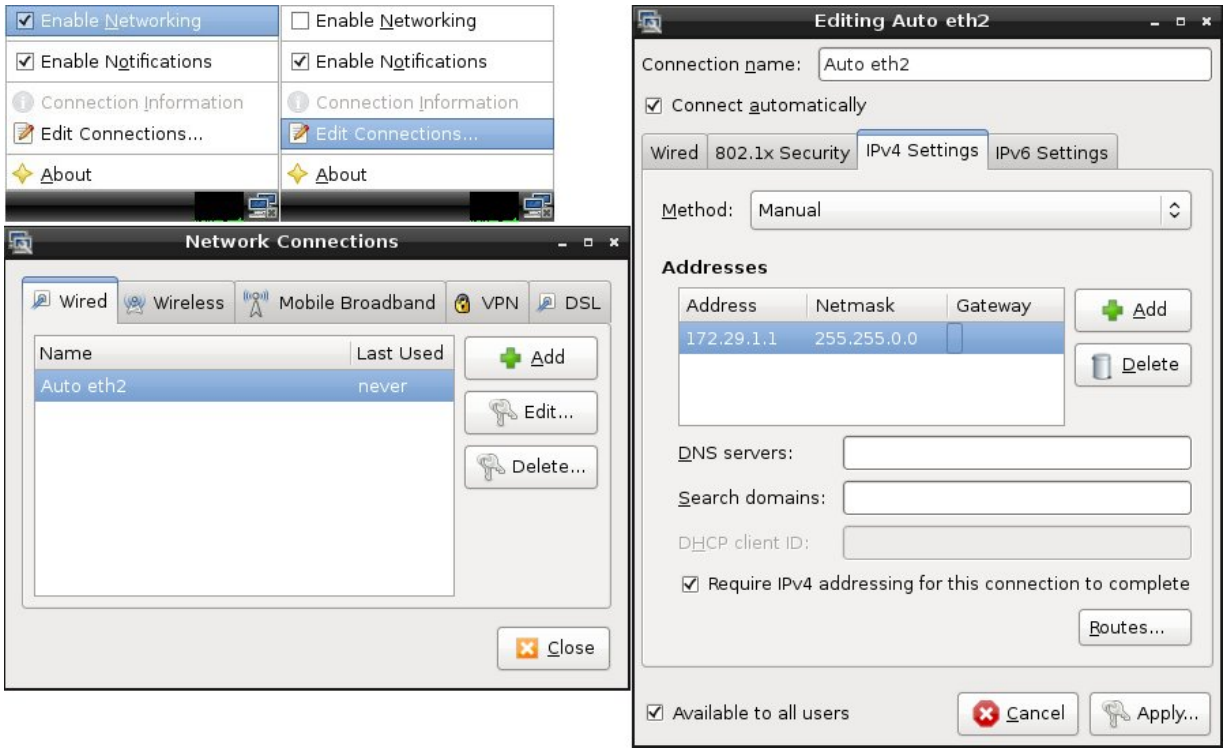
Step 5 - Start simulation
You can now plug in the dongle "MPS copy protection" in another USB port of your system and start the simulation by typing the command "mbgprotosim" on the terminal or double clicking "Run Simulation" on the desktop. At first start, there will be the hint, that you should check your system time and correct it in case that it is wrong. Please do not disregard this hint and correct your system time before clicking OK. Otherwise, Meinberg Protocol Simulation will not work accordingly.

Step 6:
You have successfully started Meinberg Protocol Simulation. Have fun with it!

4 Network configuration

If your network clients should not be automatically configured by a DHCP server, you will have to set a static IP address for each network interface before you start Meinberg Protocol Simulation for the first time. Please make sure, that the IP address you are going to configure is located in the same network as the device(s), that shall be tested.

At first, click on the networking symbol at the bottom right of the screen and deactivate your network adapters by removing the check mark for "Enable Networking". Afterwards, click "Edit Connections..." in the same menu. A new window with the title "Network Connections" will open. Choose your interface out of the wired interfaces in the list and click "Edit". Another window with the title "Editing Auto ethX" will open. Now, switch to the flag "IPv4 Settings" and choose the configuration method "Manual". Subsequently, click "Add" and type in your static IP address and an appropriate netmask in the address list. Press Enter to submit your input and apply your configuration by clicking "Apply". If you have more than just one network interface available, repeat the described steps for each interface you want to use.



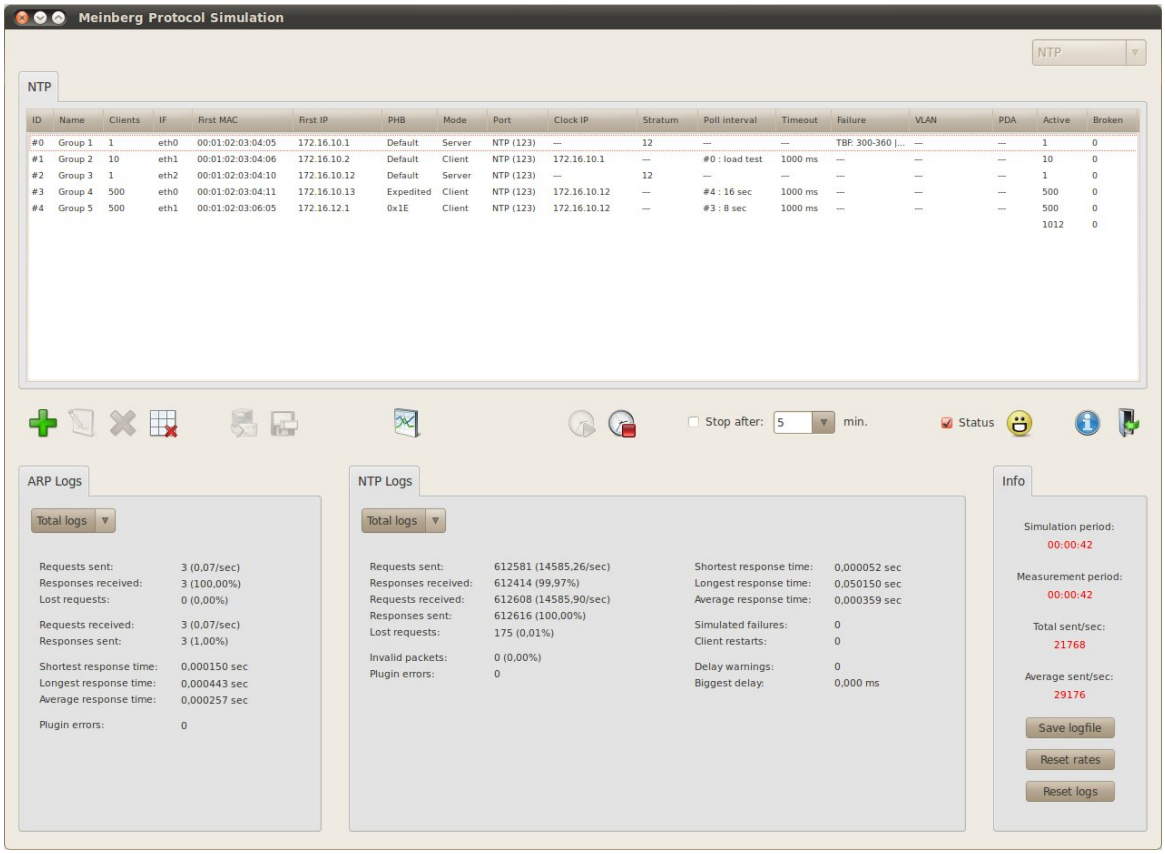
As soon as you are ready with the configuration of all your network interfaces, click "Close" in the window "Network Connections". Finally you have to reactive your network adapters by setting the check mark for "Enable Networking". The now configured addresses are saved persistently and should also be preconfigured on the next boot of the live system.

5 Installation guide

Besides booting the live system, you do additionally have the opportunity to install Meinberg Protocol Simulation on an existing Linux distribution. However, we do not recommend to install the software on another system than Debian 6 or Ubuntu 10.04, as it has been developed, tested and compiled on this systems. Of course, you can also try to run it on another system.

For installation, simply start your existing Linux system, plug in the USB stick "MPS live" in one of your systems USB ports and mount the third partition with the name "mps-setup". Go to the appropriate partition folder via terminal (i.e. /media/mps-setup) and start the installation with the command ./install. Follow the instructions in the terminal. Afterwards, you will find a shortcut on your desktop and additionally can start the simulation by typing the command "mbgprotosim".

6 Main dialog



This is the main dialog of Meinberg Protocol Simulation. In the highlighted selection box at the top right of the window, you can choose the current simulation mode. Options are NTP, PTP Unicast and PTP Multicast. You can only run one of these simulation modes at the time. When starting the actual simulation, the selection box is disabled.

Besides the protocol selection, the main dialog is divided in three parts. The upper part of the dialog is built by the group list. In the middle, you can find the main menu, whereas the logs of your current simulation are shown at the bottom of the dialog. In the following, the functions of the dialog parts are described in detail.

6.1 Group list

The group list in the upper part of the main dialog provides an overview of the configured client/server groups and their attribute values. When simulation is running, it also shows how many clients/servers are currently active or in simulated failure status. In addition to that, for the simulation of PTP unicast masters, you can see the current number of slaves. In case of a PTP multicast simulation, the exact status of the group is shown. This allows simulated multicast clients in the states listening (LIS), uncalibrated (UNC), slave (SLA), passive (PAS), master (MAS) or faulty (FAU).

6.2 Main menu

The main menu of Meinberg Protocol Simulation is set in the middle of the main dialog and allows the user to perform the following actions:

- Add client/server groups
- Edit the currently selected group
- Delete the currently selected group
- Delete the whole group configuration
- Load a saved group configuration
- Save the current group configuration
- Open the graph window
- Start the simulation
- Stop the simulation
- Configure the duration of the simulation
- Show/Hide the status smiley
- Show the information window
- Quit the program

6.3 Logs

The logs at the bottom part of the main dialog are essential for the analysis of a simulation. Here, all sent or received outbound and inbound packets are listed. This for example permits you to comprehend how many NTP requests your simulated clients have sent to the NTP server and how many of them have been responded. In addition, informations like the shortest, the longest or the average reply time can be gained. For NTP and PTP unicast, you can also track the inbound and outbound arp requests and responses. With the selection boxes in the different log areas, you can switch between group specific and global logs.

With a changing status smiley animation, depending on the current situation, the results of the simulation are being evaluated during the runtime of the simulation. High packet losses, too low outbound rates or other insufficient values are being highlighted in red, so that you can identify problems, if there are any, at first glance.

When simulating a master, especially the outbound rates of sent packages (announce/sync/follow up) are decisive. Therefore, the rates of sent packets per second are shown behind the total count of the sent packets. In this way, variations to the configured values can be quickly detected. For the multicast simulation, there is also a list of the current masters in the network.

In an own area at the right bottom of the dialog, general information is provided. Here you can see the duration time of the current simulation, the expired time since the last measurement point has been set, as well as the totally sent packets in the last second and the average sent packets per second. In addition, functions for saving the current logs, resetting the measurement rates (setting a measurement point) and resetting the current logs are provided.

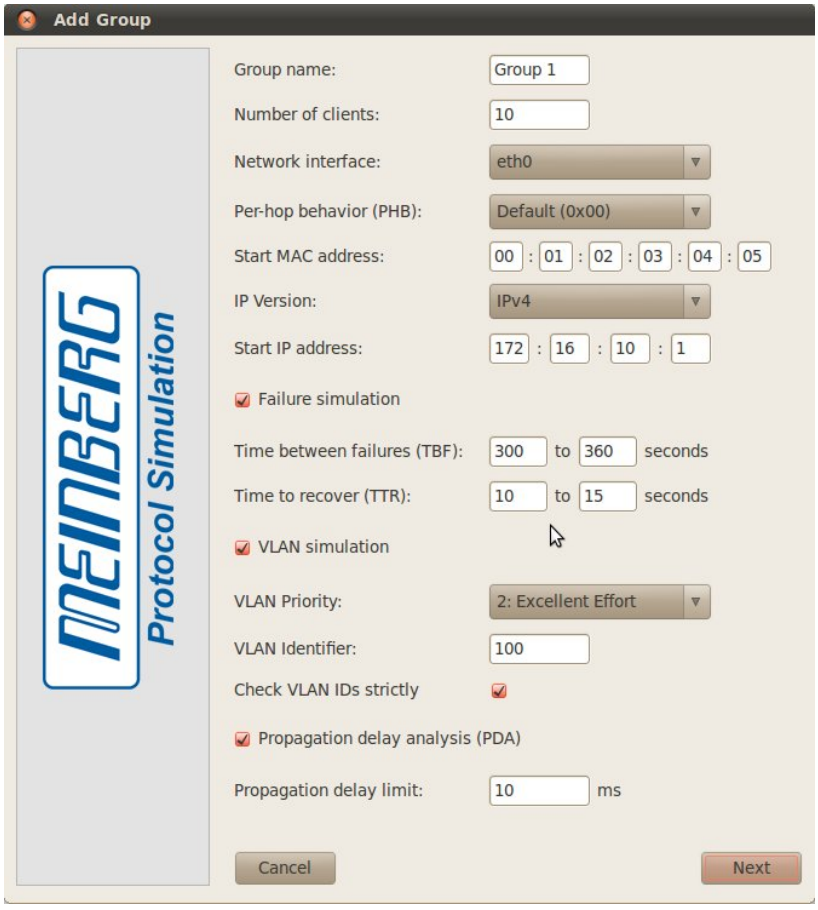
7 Group configuration

7.1 Add group

Before you can start the simulation, you have to create a group configuration according to your wishes. In doing so, you can create different groups or single clients with specific parameter settings. Besides some standard parameters, the parameters that have to be configured when adding a group to the configuration differ from protocol to protocol. Such being the case, after a short description of the standard parameters, the process of adding a group is described in detail for each protocol in the following.

Groups can also be added during the runtime of a simulation. In this way, you can dynamically increase the load on a system.

7.1.1 General parameters



Independent from the current simulation mode, there have to be configured several general parameters for every group. You have to specify a group name, the number of the simulated clients, the network interface you want to use, an automatically incremented start MAC address, the IP version and an also automatically incremented start IP address. Please make sure, that the IP address is located in the same network as the devices to be tested.

If desired, you additionally have the opportunity to configure a failure (breakdown) simulation. Breakdowns are configured in two time spans, which are the time between two failures (TBF) and the time to recover (TTR) in seconds. For each client, there will be configured a random value out of the configured time spans for TBF and TTR.

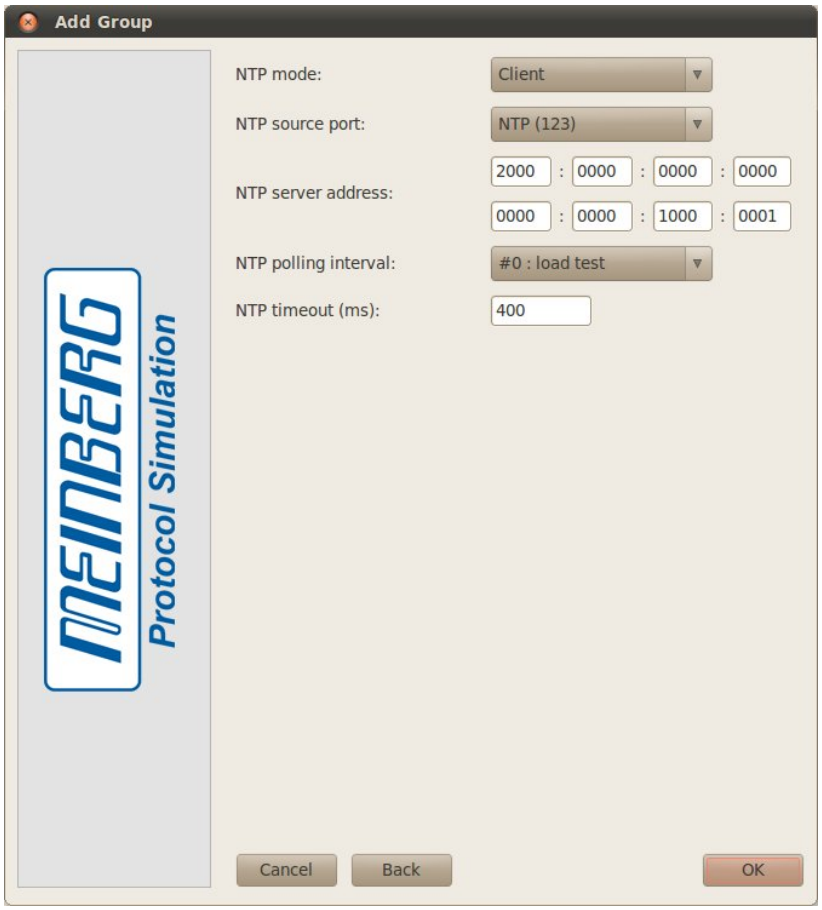
An additional option allows the simulation of VLANs. The user can configure the VLAN priority (0-7) and the VLAN-ID. Furthermore, the user can decide, whether the VLAN-ID is strictly checked when receiving VLAN packets and VLAN packets with other than the configured VLAN-ID shall be rejected.

In the end, the user can turn the analysis of propagation delay on or off and determine a warning threshold in milliseconds.

7.1.2 NTP

The process of adding NTP groups can basically be differentiated between NTP servers and NTP clients. For adding a NTP server, the user simply has to name the stratum value of the simulated server.

In contrast, the simulation needs a little more information for creating a NTP client. The user can decide, whether the client shall send its requests via the standard NTP port 123 oder a dynamically generated port. In addition, the server address, the polling interval and the timeout of requests in milliseconds has to be defined. Besides the by NTP standard defined polling intervals, the user has the opportunity to configure a NTP load test by choosing "#0 : load test" as polling interval. In this mode, there can be simulated up to 15 clients, which send a new NTP request shortly after receiving a response to a before sent request. In this way, depending on the speed of the tested NTP server, over 1000 requests per second and client can be sent.



NTP server and NTP clients can also be simulated simultaneously. On a system with two or more network interfaces installed, simulated clients can even send requests to your own simulated servers.

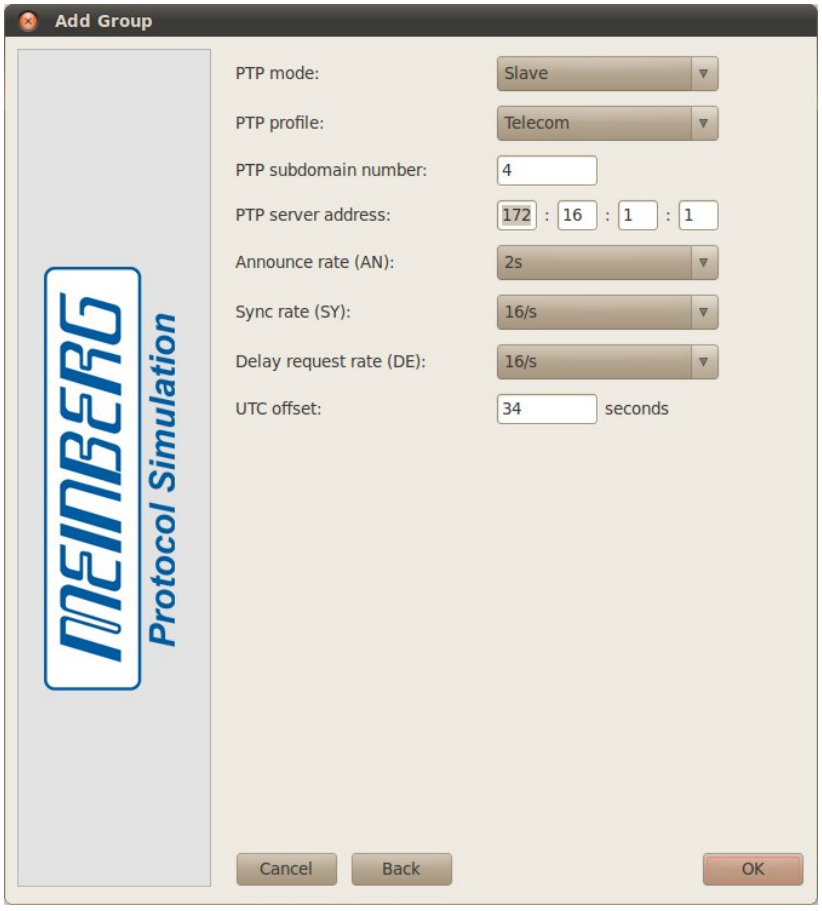
7.1.3 PTP Unicast

As for NTP groups, also PTP Unicast groups can be distinguished in two main categories, masters and slaves. Additionally, one can decide between a default profile with user specific parameters or the telecom profile with predefined parameters.

For the master, the user just has to choose the profile, the appropriate subdomain number (restricted to 4-23 in telecom profile) and the UTC offset of the simulated clock.

For the slave, in addition to the masters parameters, the server address, the announce message rate, the sync message rate and the delay request rate have to be defined. In default profile, one can choose between rates of 128/s to 128s for all message types. In telecom profile, the announce message rates are restricted to a value between 8/s and 16s and the sync message and delay request rates are restricted to a value between 128/s and 16s. Predefined parameters for the telecom profile are an announce message rate of 2s and a sync message and delay request rate of 16/s.

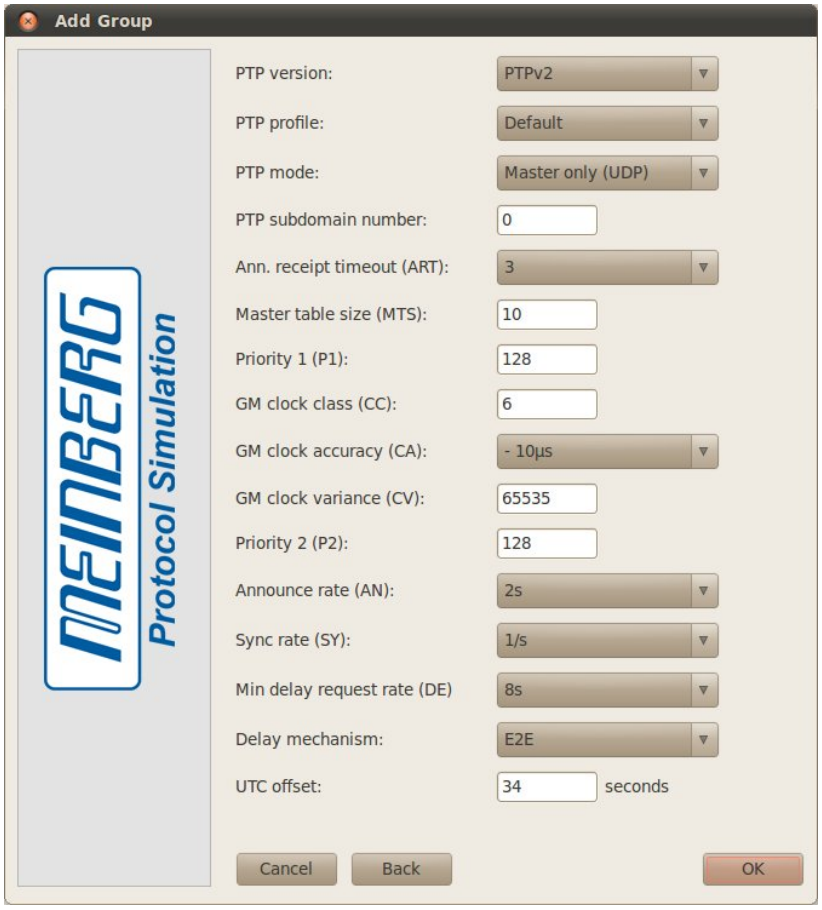
Accessorily, in telecom profile, during the receiption of announce messages, the grandmaster clock class is controlled. It has to be between 80 and 110. If it is not, this is a profile violation and will not be counted as regular announce message in the logs.



7.1.4 PTP Multicast

The configuration of PTP Multicast groups requires the biggest effort. As you can not only choose between master and slave for Multicast groups, but also between PTPv1 and PTPv2, default, power systems and peer-2-peer profile, as well as layer 2 and layer 3, up to ten different kinds of groups with further individually configurable parameters can be created. Although PTPv1 is obsolete and rarely used, there should be the opportunity to test the old generation devices, too.

Depending on the configured group kind, the user obtains different parameter options for a group. For the sake of clarity, the steps of group configuration for Multicast slaves, as for NTP and PTP Unicast, are differentiated between masters and slaves.



Unlike the configuration of NTP and PTP Unicast groups, configuring PTP Multicast groups is much more complicated than configuring slaves. Regardless of whether layer 2 or layer 3, default, power systems or peer-2-peer profile, the first configurable parameters for Multicast masters are always the same. After the choice of the version, the profile and the mode, the user has to specify the subdomain number. Thereupon, the announce receipt timeout (ART) can be defined. This declares, how many message intervals without any announce messages from the current master the simulated master shall wait, until it sends announce messages itself. The master table size specifies, how many different masters and their quality parameters the simulated master can save in its foreign master table. Default value is 10. Of course, this five quality parameters do also have to be configured for the simulated master. The values are being compared according to the following priority, whereupon the smaller value is always the better value.

- Priority 1
- Grandmaster Clock Class
- Grandmaster Clock Accuracy
- Grandmaster Clock Variance
- Priority 2

Concluding, announce message rate, sync message rate, minimal delay request rate, delay mechanism and UTC offset have to be specified. As for PTP Unicast, the options for the message rates vary from profile to profile. In default profile, one can choose a message rate of 128/s to 128s for all messages. In power systems profile, as defined in the standard, all message rates are fixed on 1/s. In peer-2-peer profile, an announce message rate of 1/s to 16s, a sync message rate of 2/s to 2s and a delay request rate of 1/s to 32s can be chosen. For the delay mechanism, the user has the opportunity to choose between E2E (end-2-end) and P2P (peer-2-peer).

As already mentioned, for the configuration of a Multicast slaves, there have to be configured much less parameters. Besides the subdomain number, the user just has to define the announce receipt timeout, which in this case stands for the number of message intervals, slaves wait for announces of the current master, before they change their modus from slave (SLA) to listening (LIS), the master table size, the delay request rate, the delay mechanism and the UTC offset.

7.2 Edit group

Some of the configured parameters can also be edited in retrospect. These are the standard parameters like the group name, the network interface, the failure and VLAN simulation parameters and the propagation delay analysis, as well as all the protocol specific parameters. Some of the parameters can also be edited during the runtime of a simulation and are instantly realized. In this way, for example the source port, the polling interval or the timeout of NTP clients can be changed with immediate effect. In PTP Unicast simulation, one can change the profile, the subdomain number, the message rates and the UTC offset. In PTP Multicast simulation, all parameters except the PTP version, the mode and the master table size can be changed.

7.3 Delete groups/s

Of course, configured groups can also be deleted. Therefore, there are the functions of deleting single clients as well as deleting all clients with one click. Groups may also be deleted during the runtime of a simulation. In this way, one can decrease the load on a system dynamically. If all groups are deleted during the runtime, the simulation will automatically be stopped.

7.4 Save/load group configuration

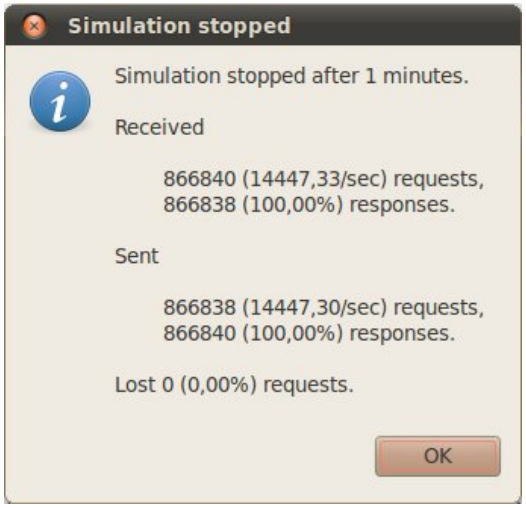
If you want to rerun a predefined test scenario later on, you have the opportunity to save your current configuration. Depending on the currently chosen protocol, the NTP, PTP Unicast or PTP Multicast groups and their parameters are being saved in a file and can be read back in at the next start of program. The groups will, depending on the protocol, be saved in a .ntp, .ptpu or .ptpm file. This file types should not be changed, as the software is not able to load other file types.

8 Simulation

As soon as you have completed the configuration of your groups, you can start the actual simulation. The configured groups begin listening on ARP requests (IPv4) or Neighbour solicitations (IPv6) with the start of the simulation and send the appropriate answers. On NTP or PTP unicast simulation, in addition to that, the clients send appropriate requests to the defined servers, to find out their MAC address. Subsequently, the protocol simulation can start. Requests are sent in the configured timespan and responses are accepted. Furthermore, for each request, the time until the answer comes in is taken and logged.

On multicast simulation, all clients, regardless of which type, start listening on announce messages to determine a master. Masters compare the announce messages, or rather the attributes of the other masters with their own attributes and decide, whether they should act as master themselves or switch to passive mode instead. Slaves listen on announce messages until they received a specific number from the determined master and switch at first to uncalibrated mode, before they switch to slave mode after another specific number of announce, sync, and delay response messages. The state of the single groups can be monitored in the group list.

Some functions are disabled for the runtime of a simulation, for example loading and saving of group configurations or switching between the different protocols. The duration of the simulation can be configured with a selection box in the main menu, where also own values can be declared. After this time has elapsed, the simulation stops automatically and an information box with the most important results of the simulation is shown.



9 Graph window

During the runtime of a simulation a graph window can be shown by clicking a button in the main menu. The graph can be filled with protocol specific, predefined data and shows the appropriate graphs. It is built up of one X-axis and two Y-axis, of which one is used for integer values, for example the number of active clients or the count of sent requests, and the other for floating-point-values, for example the number of sent requests per second or the count of received announce messages per second.

The scaling of the graph can at users option take place automatically or manually. By clicking the gears button, the automatic scaling is turned on and off. When turning the automatic scaling off, the regulators for manual scaling are enabled. With a click on the resize button at the right, the currently configured scalation can be applied. The attributes of the X-axis, as well as the attributes of the Y1- and Y2-axis may be scaled absolutely arbitrary. In addition to that, the graph affords a pause function, a reset function, a function to save the current graph as a JPG picture and a function to fade in/out labels of the currently drawed values.