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# Signal Server – UserManual

*Release 1.0*

**Christian Breitwieser – c.breitwieser@tugraz.at**

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# 1 Introduction

The TOBI signal server describes a program using TiA (TOBI interface A) to acquire and distribute raw biosignals. Implementation was done using C++, static and shared library packages are available for Debian based systems (32bit and 64 bit), Microsoft Windows Xp, and Windows 7.

## 1.1 Supported hardware

- g.USBamp (Windows only)
- g.Mobilab
- g.BSamp
- BrainProducts Brainamp series (Windows only)
- generic joysticks
- software sine generator
- LifeTool IntegraMouse
- Generic mice

## 1.2 Planned hardware support

- National Instruments DAQ cards
- Generic Keyboards
- NIRx NIRScout
- Neurosky MindSet
- Tunable EEG simulator
- Arduino embedded DAQ system

## 1.3 Planned extensions

- remote configuration
- client-based channel and sampling rate selection
- acquired data storage using .gdf files
- streaming of stored files

## 1.4 License

The TOBI signal server is licenced under the [GPLv3](#).

## 1.5 Contact

For further information please contact [SignalServer@tobi-project.org](mailto:SignalServer@tobi-project.org).

## 2 Changelog

### 2.1 Signal Server v0.2

- Introduced xml message version 0.2

This message version upgrade makes Signal Server 0.1 **incompatible** with version 0.2.

- 0.1 server / 0.2 client

The connection with the Signal Server is aborted. The client throws an exception and/or displays an error message.

- 0.2 server / 0.1 client

The connection with the Signal Server is aborted. The server displays an error message but keeps running.

- Added brainamp series support
- Partly added EEG simulator support
- Added g.BSamp support
- Fixed g.USBamp timeout bug after restart
- Various bugfixes

## 3 Hardware Requirements

- CPU: at least 200 MHz  
(already tested on embedded systems, highly dependent on sampling rate and number of acquired channels)
- RAM: 32 MB
- Run the Signal Server with highest process priority

For networking usage:

- Ethernet min. 100 MBit (1 GBit recommended)  
Needed network connection bandwidth varying by the sampling rate and the number of channels acquired.

## 4 Installation Instruction

### 4.1 Hardware Drivers

To use data acquisition devices as g.tec's g.USBamp, the respective drivers, provided by the manufacturer have to be installed first.

**Drivers provided by the manufacturers:**

- g.USBamp (Windows only)
- BrainProducts Brainamp series (Windows only)

### 4.2 Debian/Ubuntu

Download libtia.deb and signalserver.deb for your respective operating system and platform (32 or 64 bit). Install it with your preferred packet manager (e.g. synaptic). libtia.deb has to be installed first.

*All required files are available at [www.tobi-project.org/download](http://www.tobi-project.org/download).*

## 4.3 Windows

Download the Signal Server setup file and install it.

All required files are available at [www.tobi-project.org/download](http://www.tobi-project.org/download).

# 5 Using the Signal Server

## 5.1 Generic Usage

The Signal Server is shipped with two demo configuration files (“server\_config\_comments.xml” and “server\_config.xml”). Those files are showing exemplary configurations of the Signal Server. The “\_com-mets.xml” file is equipped with additional comments to facilitate understanding the configuration of the Signal Server.

The Signal Server can be started by a quickstart where the file “server\_config.xml” is automatically read (operating system dependent) or by passing an individual config file to the Signal Server.

### Start Commands for individual config files:

```
signalserver your_config_file.xml
```

o r

```
signalserver -f your_config_file.xml
```

### Commands while the Signal Server is running:

q ... stop

r ... restart (problems with various DAQ devices – bugfix in progress)

l ... list possible hardware devices

h ... help

## 5.2 Debian/Ubuntu

With the first start of the Signal Server, a folder named “tobi\_sigserver\_cfg” is automatically created within the users home folder. Two files named “server\_config\_comments.xml” and “server\_config.xml” are located inside this folder.

Starting the Signal Server without any parameters automatically reads and starts the “server\_config.xml” inside the “tobi\_sigserver\_cfg” folder (quickstart).

## 5.3 Windows

Starting the Signal Server without any parameters (quickstart), the program automatically reads and starts the “server\_config.xml” inside the folder where the Signal Server is installed (e.g. C:\Program Files\TOBI SignalServer\server\_config.xml).

To use a different configuration, another .xml file can be handed to the Signal Server either using the commandline or just dragging the respective file on the Signal Server executable or a link to it.

# 6 The XML Configuration File – Basics

This is just a general description of the XML configuration file.

## 6.1 Subject Information

This tag has to be used to store meta information from the respective subject or patient participating in the measurement. (Self-explanatory tags are not described here, e.g. birthday)

*Exactly one <subject> tag has to be inside the XML configuration file.*

```
<subject>
  <id> asd52 </id>
  <first_name> Nobody </first_name>
  <surname> Nowhereman </surname>
  <sex> m </sex>
  <birthday> 31.12.1900 </birthday>
  <handedness> r </handedness>
  <medication> none </medication>

  <optional glasses="yes" smoker="no" />
</subject>
```

- ID

The subjects identification code (e.g. ch17b)

- Optional

The optional tag can be extended at will (e.g. technician = “tec1”)

## 6.2 Server Settings

Inside this tag the Signal Server except its attached hardware is configured.

*Exactly one <server\_settings> tag has to be inside the XML configuration file.*

```
<server_settings>
  <ctl_port> 9000 </ctl_port>
  <udp_port> 9998 </udp_port>
  <udp_bc_addr> 127.0.0.255 </udp_bc_addr>
</server_settings>
```

- ctl\_port

A TCP port every client is connected to. This port has to be specified at the client (together with the IP address the server is running on; if the same machine is used, the IP address is 127.0.0.1) when connecting to the Signal Server.

The Signal Server supports data transmission via UDP (reduced packet overhead, no guarantee that all data is transmitted to the client). If a client requests UDP transmission UDP packets are broadcasted into the whole subnet specified inside this tag.

Sending UDP packets to an address in an other subnet or two different ports is not supported yet.

- udp\_port

The target port.

- udp\_bc\_addr

The broadcast address to transmit UDP packets to (e.g. 192.168.1. **255** – packets are sent to every computer with an IP 192.168.1.XXX ).

## 6.3 The Hardware sections

The Signal Server supports data acquisition from multiple devices at the same time. For this reason every device has its own hardware tag. Thus more than one hardware section is allowed inside the XML configuration file.

```
<hardware name="sinegenerator" version="1.0" serial="">
  <mode> master </mode>
  <device_settings>
    <sampling_rate> 512 </sampling_rate>
    <measurement_channels nr="1" names="eeg" type="eeg" />
    <blocksize> 8 </blocksize>
  </device_settings>

  <channel_settings>
    <selection>
      <ch nr="01" name="C3" type="eeg" />
      <ch nr="02" name="Cz" type="eeg" />
      <ch nr="03" name="Hand" type="emg" />
    </selection>
  </channel_settings>
</hardware>
```

### Hardware

```
<hardware name="sinegenerator" version="1.0" serial="">
```

- Name

This attribute defines the respective hardware device to acquire data from.

- Version

Not used yet. (May be removed in the future.)

- Serial

Serial number of the device if available. Processed at particular devices (e.g. g.USBamp).

### Mode

Possible values are:

- Master
- Slave
- Aperiodic

e.g. buttons; data is only delivered if a value is altered

Inside the XML configuration file **exactly one device** has to be defined as master, all others have to be slave or aperiodic devices. The master device **must** have the highest “virtual” sampling rate compared to possible slave devices.

Virtual sampling rate = sampling rate / blocksize (e.g. fs = 512 Hz, bs = 8 ... v\_fs = 64 Hz)

Data is acquired from the master in blocking mode. Every time data is available at the master, the latest data is acquired from all slaves and aperiodic devices. There is **no software synchronization** of the acquired data!

Not all devices support master, slave, and aperiodic mode.

## Device Settings

In this tag settings affecting the whole data acquisition device and not only particular channels are specified.

The simplest data acquisition device has at least a sampling rate, a blocksize and a certain number of channels.

- Sampling Rate

The sampling rate data is acquired with.

- Blocksize

The number of samples grouped together before transmission.

- Measurement Channels

*(This setting can be used for quick configuration; all channels get the same name and the same signal type. For individual channel names and signal types use the channel setting section.)*

- nr

The number of channels to acquire, starting at channel 1.

- names

The name for **all** channels.

- type

The signal type for **all** channels.

Samples are grouped into blocks from the same channel if a blocksize >1 is used (e.g. block size = 2: ch1s1 ch1s2; ch2s1 ch2s2; ...) and transmitted inside the same data packet. Altering the blocksize does not affect the sampling rate itself, but the rate data packets are transmitted over the network.

Using a sampling rate of 1000 Hz and a blocksize of 10, samples are still acquired with 1000 Hz, but data packets are sent with only 100 Hz, whereby every packet stores 10 samples for all acquired channels.

As incoming packets are used for timing control at the client, a bigger blocksize introduces a certain jitter, as the client has to wait for a new packet storing more than one sample and processes all samples immediately afterwards.

*Some hardware devices have to be used with a blocksize >1 to avoid data acquisition errors!*

## Channel Settings

The channel settings tag can be used to customize individual channels and override settings done in the device settings section.

- Selection

Select only specific channels for recording. The sum of all channels here can be different from the settings done in measurement\_channels in device\_settings. Settings here override the prior channel selection!

```
<ch nr="01" name="Cz" type="eeg" />
```

```
<ch nr="02" name="C3" type="eeg" />
```

- nr

Number of a channel to acquire data from.

- name

The name for the respective channel (e.g. Cz).

- type

The signal type for the respective channel (e.g. eeg).

## 7 Specific Hardware Section Configuration with the XML Config File

### 7.1 Sine Generator

The Sine Generator is a hardware emulator creating a 1 Hz sine with an amplitude of 1. The phase is increased every 4 channels.

```
<hardware name="sinegenerator" version="1.0" serial="">
  <mode> master </mode>
  <device_settings>
    <sampling_rate> 512 </sampling_rate>
    <measurement_channels nr="1" names="eeg" type="eeg" />
    <blocksize> 8 </blocksize>
  </device_settings>

  <channel_settings>
    <selection>
      <ch nr="01" name="C3" type="eeg" />
      <ch nr="02" name="Cz" type="eeg" />
      <ch nr="03" name="Hand" type="emg" />
    </selection>
  </channel_settings>
</hardware>
```

### 7.2 EEG Simulator

The EEG Simulator is a hardware emulator generating normal distributed random noise with variable amplitude and offset. It is furthermore possible to add a sine to the simulated EEG signal (e.g. to test a classifier).

An external control program to modify the EEG simulators parameters is currently in development.

```
<hardware name="eegsim" version="1.0" serial="">
  <mode> master </mode>
  <device_settings>
    <sampling_rate> 500 </sampling_rate>
    <measurement_channels nr="48" names="eeg_name" type="eeg" />
    <blocksize> 1 </blocksize>
    <port> 9123 </port>

    <eeg_config scaling="1" offset="1" />
    <sine_config frequ="2" amplitude="1" phase="0" />
  </device_settings>

  <channel_settings>
    <selection>
      <ch nr="01" name="eeg" type="eeg" />
      <ch nr="02" name="eeg" type="eeg" />
      <ch nr="03" name="eeg" type="eeg" />
    </selection>

    <eeg_config>
      <ch nr="01" scaling="1" offset="-500" />
      <ch nr="02" scaling="1" offset="0" />
      <ch nr="03" scaling="1" offset="0" />
    </eeg_config>

    <sine_config>-->
      <!--WARNING: device settings are not overwritten here!
```



```

        sines are added to the signal; multiple entries per channel possible-->
        <ch nr="01" frequ="2" amplitude="100" phase="0" />
        <ch nr="01" frequ="4" amplitude="1000" phase="0" />
        <ch nr="02" frequ="3" amplitude="100" phase="0" />
        <ch nr="03" frequ="6" amplitude="100" phase="0" />
    </sine_config>

</channel_settings>
</hardware>

```

## 7.3 g.USBamp

The g.USBamp is a multipurpose biosignal DAQ device produced by g.tec (Guger Technologies, Graz, Austria).

```

<hardware name="g.usbamp" version="1.4" serial="UA-2008.06.42">
    <mode> master </mode>
    <device_settings>
        <sampling_rate> 512 </sampling_rate>
        <measurement_channels nr="1" names="eeg" type="eeg" />
        <blocksize> 8 </blocksize>

        <filter type="chebyshev" order="8" f_low="0.5" f_high="100"/>
        <notch f_center="50"/>

        <shortcut> off </shortcut>

        <usbamp_master> yes </usbamp_master>

        <common_ground>
            <gnd block="a" value="1" />
            <gnd block="b" value="1" />
            <gnd block="c" value="1" />
            <gnd block="d" value="1" />
        </common_ground>

        <common_reference>
            <cr block="a" value="1" />
            <cr block="b" value="1" />
            <cr block="c" value="1" />
            <cr block="d" value="1" />
        </common_reference>
    </device_settings>

    <channel_settings>
        <selection>
            <ch nr="01" name="eeg" type="eeg" />
            <ch nr="02" name="eeg" type="eeg" />
            <ch nr="03" name="eeg" type="eeg" />
            <ch nr="04" name="eeg" type="eeg" />
            <ch nr="05" name="eeg" type="eeg" />
            <ch nr="06" name="eeg" type="eeg" />
            <ch nr="07" name="eeg" type="eeg" />
            <ch nr="08" name="eeg" type="eeg" />
            <ch nr="09" name="eeg" type="eeg" />
            <ch nr="10" name="eeg" type="eeg" />
            <ch nr="11" name="eeg" type="eeg" />
            <ch nr="12" name="eeg" type="eeg" />
            <ch nr="13" name="eeg" type="eeg" />
            <ch nr="14" name="eeg" type="eeg" />
            <ch nr="15" name="eeg" type="eeg" />
            <ch nr="16" name="eeg" type="eeg" />
        </selection>
    </channel_settings>

```

```

</selection>

<filter>
  <ch nr="15" type="chebyshev" order="8" f_low="0.5" f_high="30"/>
  <ch nr="16" type="chebyshev" order="8" f_low="0.5" f_high="60"/>
</filter>

<notch>
  <ch nr="15" f_center="50"/>
  <ch nr="16" f_center="50"/>
</notch>

<bipolar>
  <ch nr="1" with="16" />
  <ch nr="2" with="3" />
</bipolar>

</channel_settings>
</hardware>

```

## 7.4 g.Mobilab

The g.Mobilab and the g.Mobilab+ are portable multipurpose biosignal DAQ systems produced by g.tec (Guger Technologies, Graz, Austria). Both are available in two configurations, either able to acquire just EEG or also other biosignals as EOG and ECG. The g.Mobilab+ is can be connected via Bluetooth emulating a serial port.

Up to now only the g.Mobilab has been tested, but the g.Mobilab+ should work as well as the API is the same.

```

<hardware name="g.mobilab" version="1.0" serial="">
  <mode> master </mode>
  <device_settings>
    <serial_port> /dev/ttyS0 </serial_port>
    <mobilab_type> eeg </mobilab_type>
    <measurement_channels nr="1" names="eeg" type="eeg" />
    <blocksize> 1 </blocksize>
  </device_settings>

  <channel_settings>
    <selection>
      <ch nr="01" name="eeg" type="eeg" />
      <ch nr="02" name="eeg" type="eeg" />
    </selection>
  </channel_settings>
</hardware>

```

## 7.5 g.BSBamp

The g.BSBamp is a multipurpose biosignal DAQ device produced by g.tec (Guger Technologies, Graz, Austria). Different variants are available. Device suitable for EEG, ECG, and EOG data acquisition or devices able to acquire just one of those signal types. The g.BSBamp is acquired using National Instruments (Austin, TX, USA) DAQ cards.

```

<hardware name="g.bsamp" version="2004" serial="BS-2004.08.02">
  <mode> master </mode>
  <device_settings>
    <sampling_rate> 512 </sampling_rate>
    <measurement_channels nr="1" names="eeg" type="eeg" />
    <blocksize> 1 </blocksize>
    <filter type="eeg" f_high="100" notch="on" f_low="2" sense="0.1" />

```

```

    <filter type="eog" f_high="100" notch="on" f_low="2" sense="1" />
    <filter type="emg" f_high="100" notch="on" f_low="2" sense="5" />
    <filter type="ecg" f_high="100" notch="on" f_low="2" sense="5" />
    <notch f_center="50"/>
</device_settings>

<channel_settings>
  <selection>
    <ch nr="01" name="eeg" type="eeg" />
    <ch nr="02" name="eeg" type="eeg" />
  </selection>

  <filter>
    <ch nr="2" type="eeg" f_high="30" notch="off" f_low="0.01" sense="0.05"/>
    <ch nr="15" type="ecg" f_high="100" notch="off" f_low="0.01" sense="5"/>
  </filter>
</channel_settings>
</hardware>

```

## 7.6 Brainamp Series

**Insert some text.**

```

<hardware name="brainamp" version="1.0" serial="">
  <mode> master </mode>
  <device_settings>
    <sampling_rate> 500 </sampling_rate>
    <measurement_channels nr="2" names="eeg" type="eeg" />
    <blocksize> 5 </blocksize>

    <use_low_impedance> no </use_low_impedance>
    <trigger_hold_value> 0 </trigger_hold_value>

    <lowpass_250Hz> off </lowpass_250Hz>
    <dc_coupling> off </dc_coupling>
    <resolution> 100nV </resolution>

    <calibration_mode on="no" signal="sine" freq="10" />
  </device_settings>

  <channel_settings>
    <selection>
      <ch nr="01" name="eeg" type="eeg" />
      <ch nr="01" name="eog" type="eog" />
      <ch nr="01" name="emg" type="emg" />
      <ch nr="01" name="bp" type="bp" />
    </selection>

    <lowpass_250Hz>
      <ch nr="1" value="on"/>
      <ch nr="16" value="off"/>
    </lowpass_250Hz>

    <dc_coupling>
      <ch nr="1" value="on"/>
      <ch nr="16" value="off"/>
    </dc_coupling>

    <resolution>
      <ch nr="1" value="100nV"/>
      <ch nr="16" value="152muV"/>
    </resolution>
  </channel_settings>
</hardware>

```

```
    </resolution>

  </channel_settings>
</hardware>
```

## 7.7 Generic Joysticks

**Insert some text.**

```
<hardware name="joystick" version="1.0" serial="">
  <mode> aperiodic </mode>
  <device_settings>

    </device_settings>
</hardware>
```

## 7.8 IntegraMouse + Generic Mouses

**Insert some text.**

```
<hardware name="mouse" version="1.0" serial="">
  <mode> aperiodic </mode>
  <device_settings>
    <vendorid> 1351 </vendorid>
    <productid> 4136 </productid>
    <usb_port> 130 </usb_port>

    <devcon_path> C:\WinDDK\7600.16385.1\tools\devcon\i386\devcon.exe </devcon_path>

  </device_settings>
</hardware>
```

---