OpenTechnologies
my server 3DVBT

User guide

This device uses the following technologies: Raspberry Pi computer, Raspbian operating system based on Debian, Tvheadend software. Raspberry Pi is a trademark of the Raspberry Pi Foundation, Debian is a trademark of Software in the Public Interest, Inc.

The latest version of the manual can be found at myserver.opentechnologies.pl

myserver.opentechnologies.pl
Wagrowska 14, 61-369 Poznan, Poland
Version 1.0, 2017

1 QUICK START

This section contains information that allows you to start using the TV server. In other sections you will find additional information.

1.1 FEATURES

The server, when connected to a TV antenna, allows you to watch terrestrial television broadcast in DVB-T standard:

- on your computer, tablet, smartphone, as well as on a TV or a monitor with HDMI input using a smart TV box
- on devices being away from the antenna cable thanks to a computer network
- on several devices at once:
  - on 1, 2 or 3 devices - any television channels
  - on 4 and more[1] devices - any television channels from 3 selected multiplexes/frequencies

1.2 REQUIREMENTS

- sufficiently strong DVB-T signal from individual or integrated reception system TV antenna
- access to a computer network with the following speed:
  - for TV server: upload at least 6Mb/s · planned number of receiving devices (for HD transmissions)
  - for receiving device: download at least 6 Mb/s (for HD transmission)
- receiving device (computer, tablet, smartphone or smart TV box) strong enough or with the appropriate drivers to decode H.264 HD video

1.3 PACKAGE CONTENT

The package contains:

- TV server
- power supply
- adapter enabling connecting TV server to antenna cable with IEC plug
- Ethernet cable
- this user guide
- card with passwords
- micro SD card adapter (you may need it in the future to resolve potential problems)

[1] the exact maximum number of devices has not yet been checked (it is not greater than 20 for HD transmission)

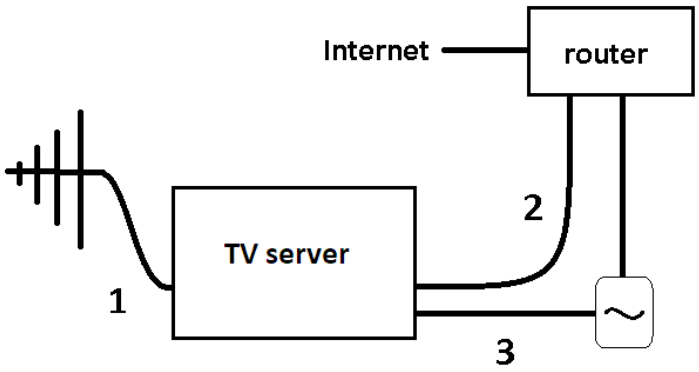
1.4 TV SERVER CONFIGURATION

1.4.1 Connecting cables

Connect TV server to:

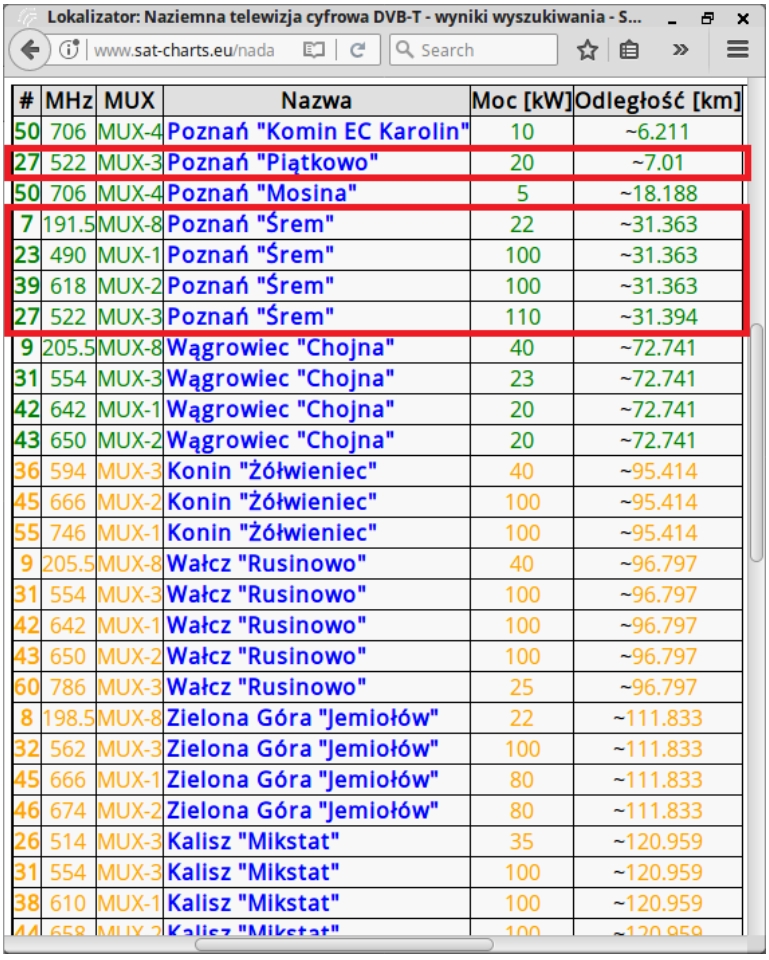
1. antenna cable - you can use the included IEC to F adapter,
2. router using supplied Ethernet cable,
3. power supply cable and finally connect the power supply to a power socket.

TV Server will start within a few dozens of seconds.



1.4.2 Setting frequencies of television transmitters

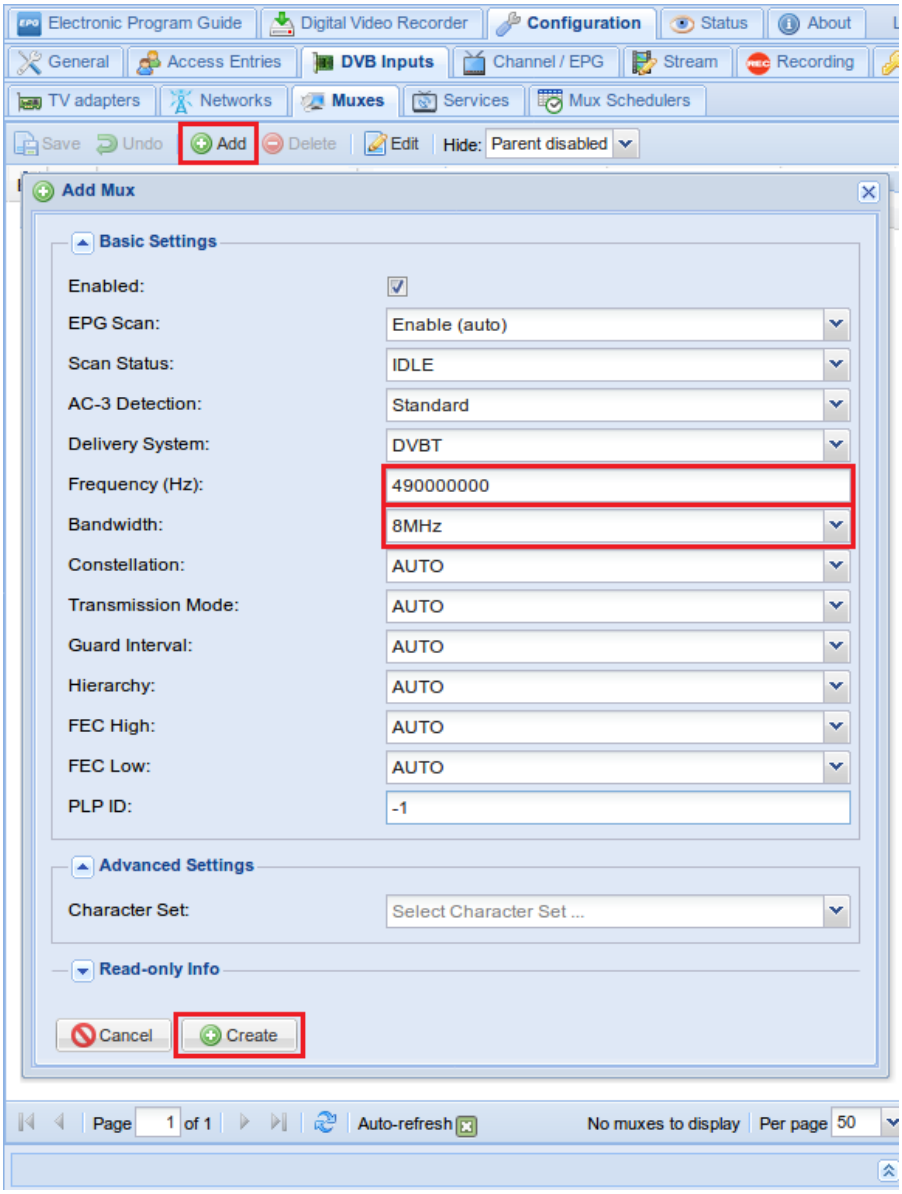
1. Find out on which frequencies terrestrial television is broadcast in your area. For example in Poznan (Poland) terrestrial television is broadcast on the following frequencies: MUX-1 - 490 MHz, MUX-2 - 618 MHz, MUX-3 - 522 MHz and MUX-8 - 191.5 MHz.
2. Open a web browser on a computer connected to the same router as TV server. Type in this address: http://raspberrypi:9981 and enter user name *tvadmin* and password written on the supplied sheet.

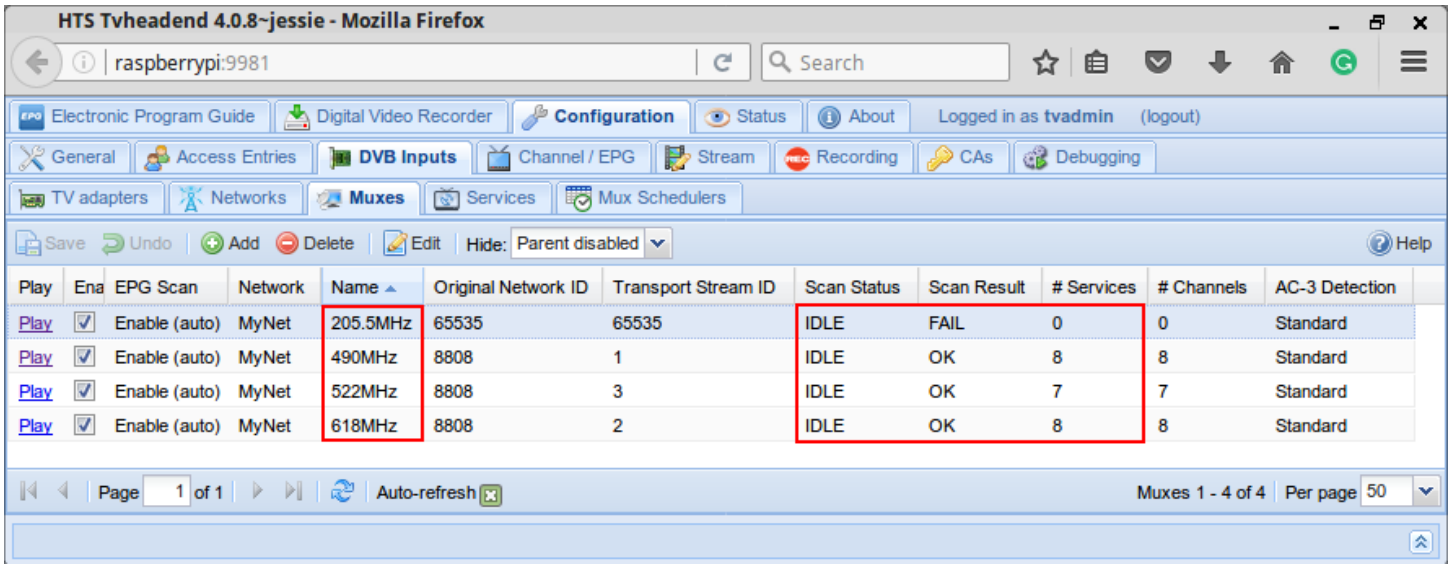


#	MHz	MUX	Nazwa	Moc [kW]	Odległość [km]
50	706	MUX-4	Poznań "Komin EC Karolin"	10	~6.211
27	522	MUX-3	Poznań "Piątkowo"	20	~7.01
50	706	MUX-4	Poznań "Mosina"	5	~18.188
7	191.5	MUX-8	Poznań "Śrem"	22	~31.363
23	490	MUX-1	Poznań "Śrem"	100	~31.363
39	618	MUX-2	Poznań "Śrem"	100	~31.363
27	522	MUX-3	Poznań "Śrem"	110	~31.394
9	205.5	MUX-8	Wągrowiec "Chojna"	40	~72.741
31	554	MUX-3	Wągrowiec "Chojna"	23	~72.741
42	642	MUX-1	Wągrowiec "Chojna"	20	~72.741
43	650	MUX-2	Wągrowiec "Chojna"	20	~72.741
36	594	MUX-3	Konin "Żółwieniec"	40	~95.414
45	666	MUX-2	Konin "Żółwieniec"	100	~95.414
55	746	MUX-1	Konin "Żółwieniec"	100	~95.414
9	205.5	MUX-8	Wałcz "Rusinowo"	40	~96.797
31	554	MUX-3	Wałcz "Rusinowo"	100	~96.797
42	642	MUX-1	Wałcz "Rusinowo"	100	~96.797
43	650	MUX-2	Wałcz "Rusinowo"	100	~96.797
60	786	MUX-3	Wałcz "Rusinowo"	25	~96.797
8	198.5	MUX-8	Zielona Góra "Jemiołów"	22	~111.833
32	562	MUX-3	Zielona Góra "Jemiołów"	100	~111.833
45	666	MUX-1	Zielona Góra "Jemiołów"	80	~111.833
46	674	MUX-2	Zielona Góra "Jemiołów"	80	~111.833
26	514	MUX-3	Kalisz "Mikstat"	35	~120.959
31	554	MUX-3	Kalisz "Mikstat"	100	~120.959
38	610	MUX-1	Kalisz "Mikstat"	100	~120.959
44	658	MUX-2	Kalisz "Mikstat"	100	~120.959

3. Go to *Configuration > DVB Inputs > Muxes* tab.
4. For each frequency you want to receive:
   - press the *Add* button,
   - select *MyNet* in *Network* field,
   - enter this frequency in hertz (i.e. multiplied by one million) in *Frequency* field,
   - select proper bandwidth in *Bandwidth* field,
   - press the *Create* button.

   TV Server will scan specified frequency. *Scan status* will change from *PEND* to *ACTIVE*, and then within several seconds to *IDLE*. If the *Scan Result* is *OK* and *# Services* > 0, this means that the signal has been properly recognized. *Scan Result* = *FAIL* means that signal in the antenna cable is too weak or that you have entered the frequency incorrectly.



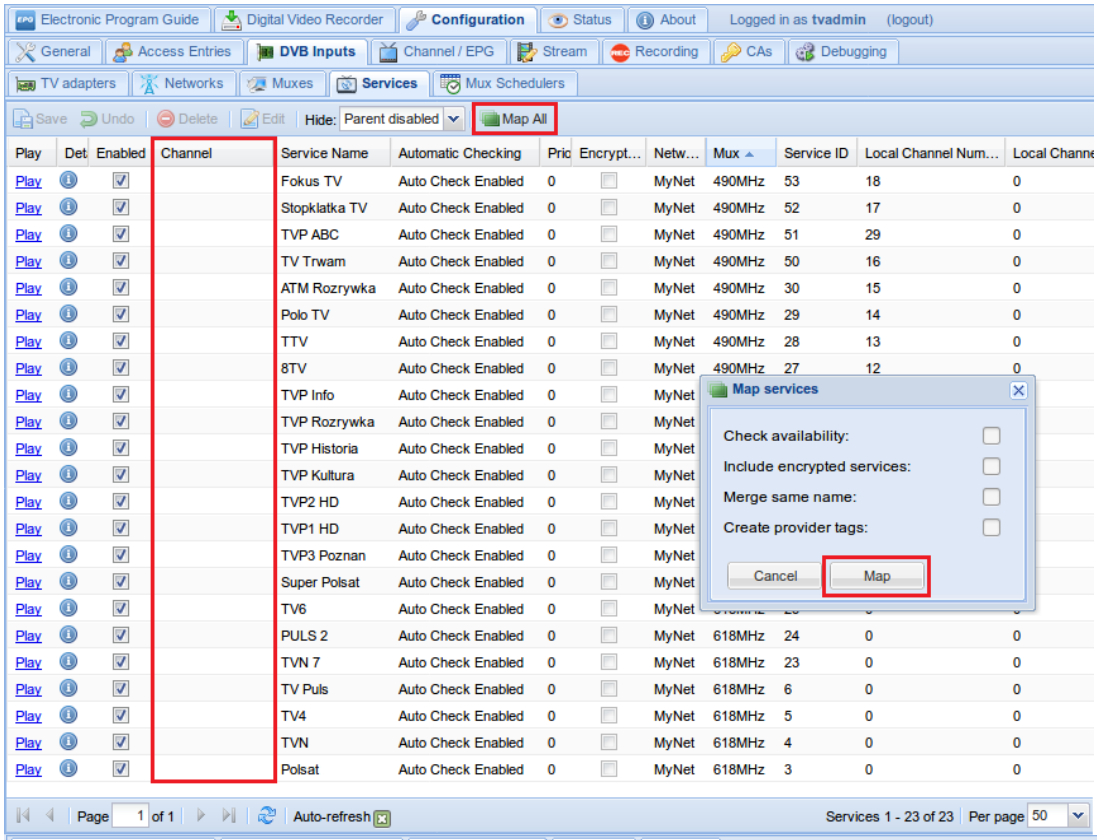


1.4.3 Setting TV channels

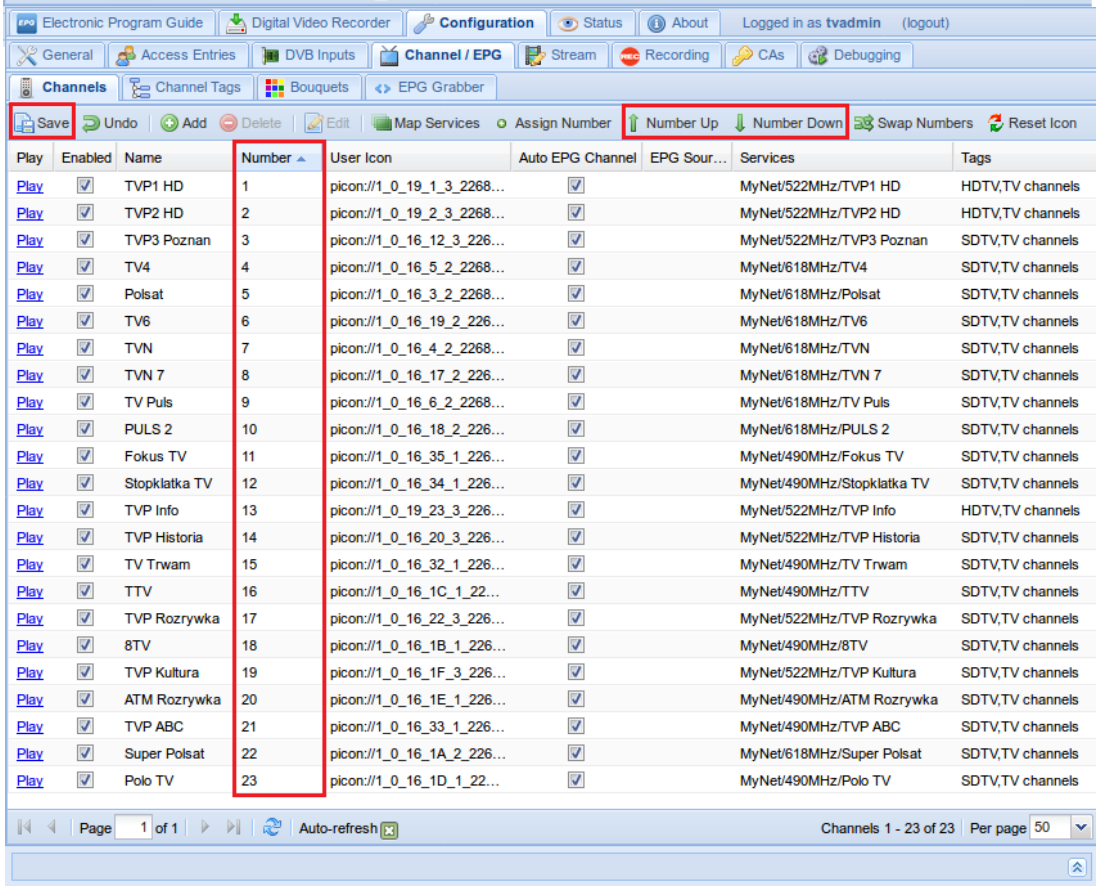
1. Go to *Configuration* > *DVB Inputs* > *Services* tab.
2. Press *Map All* button and then press *Map* in *Map services* window.

Channel names will appear in *Channel* column and also will be added to *Channel/EPG* tab.

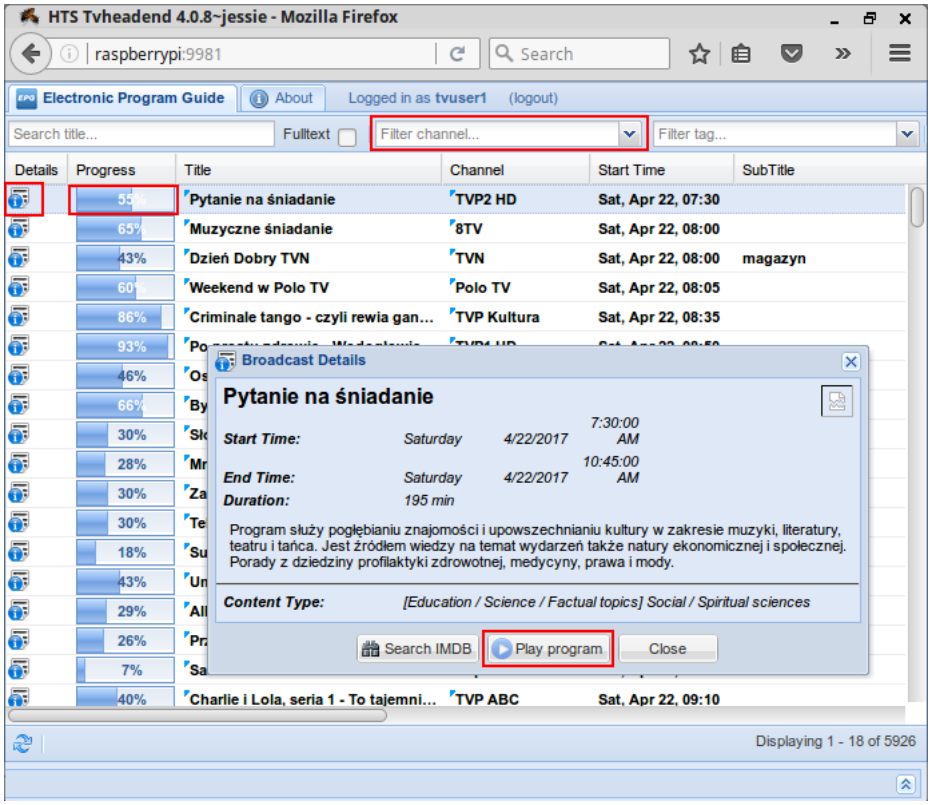
3. Close *Service Mapper Status* window, and then go to the *Channel/EPG* tab.



4. Set order of channels by changing values in the *Number* column using *Number Up* and *Number Down* buttons. Save the settings by pressing *Save* button.
5. Log out by pressing the *(logout)* link at the top of the page.



1.5 WATCHING TV



1. Type http://raspberrypi:9981 address in your web browser and then enter user name *tvuser1* and password written on the supplied sheet. You will see a list of programs.
2. If progress bar appears in the *Progress* column, it means that a program is broadcast on a channel at this moment and you can watch it.
3. Optionally, to narrow the list of programs, you can select the channel which you want to watch in the *Filter channel ...* field.
4. In the *Details* column click on the icon of the program broadcast right now.
5. Click the *Play program* button and open video stream in any video player - for example in VLC.

If you are using VLC then check *Video > Deinterlace > Automatic* item in the menu to remove interlace. In VLC you can:

- change audio track in *Audio > Audio Track* menu,
- display subtitles in *Subtitle > Sub Track* menu.

In the last section, you can learn how to watch TV in other ways. The most convenient way to watch TV is to use Kodi program.

1.6 PRECAUTIONS

- Just as with regular computer, avoid disconnecting the server from power supply without closing operating system. One of ways to close the system is to connect to it using Remote Desktop, and then select *Shutdown … > Shutdown* from Start menu. You can find out how to connect using Remote Desktop later in this manual. If you will not obey this rule it may happen that you will have to reinstall operating system on the device.
- The server can be turned on only indoor.
- Place the server in such place that it cannot fall accidentally.
- Do not block ventilation holes.
- The server similarly to TV connected to an antenna can be exposed to surge caused by lightning. You can protect it better by plugging the appropriate surge protector between the server and the antenna cable.
- Do not place the server near heating devices nor expose it to direct sunlight.
- Do not place server near flammable objects.

1.7 DEVICE DISPOSAL

Do not dispose the server nor power adapter to household waste.

2 TV SERVER CONFIGURATION

Read the information provided in the *Quick Start* section. In the current section additional information will be given.

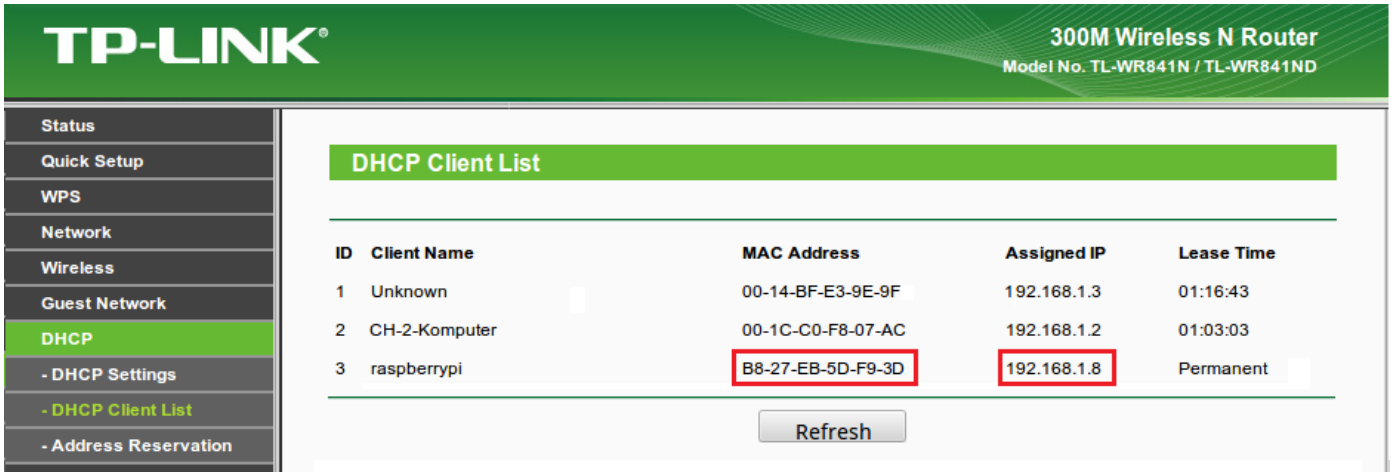
2.1 CONNECTING SERVER

- Use a power adapter with output voltage 5.1 V and maximum current of at least 2.5 A.
- TV server can optionally be connected to the computer network by Wi-Fi. In buildings with a large number of Wi-Fi networks it is recommended to connect the device to a network by cable to improve the quality of the network connection. Otherwise, neighbouring Wi-Fi networks can interfere with local Wi-Fi network which can lead to a problem with the smooth playback of television.
- If Torrent client, or another program sending large amount of data to the Internet, is used in the same network together with the TV server or a receiving device then introduce traffic management on computers with this software. You can, for example, limit the upload speed and the total number of connections in µTorrent program. Otherwise, there can be problem with smooth playback of television.

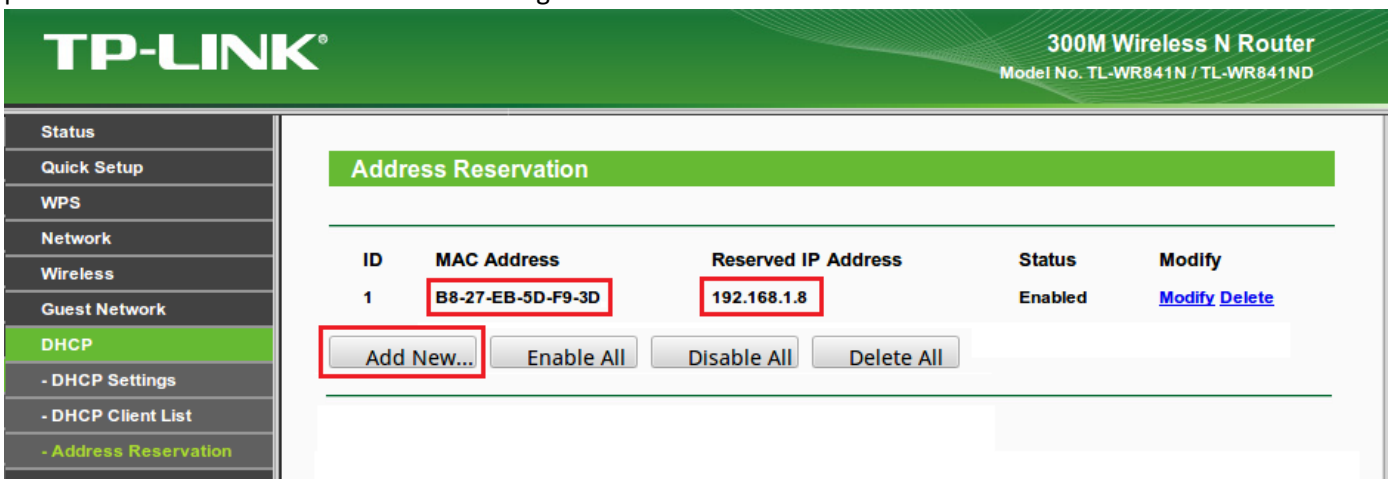
2.2 ACCESS TO TV SERVER FROM OUTSIDE LOCAL COMPUTER NETWORK

If you want to be able to watch TV and/or configure the server while being connected to a network other than the one in which the TV server is located, you should configure a router to redirect some request from the external network to the TV Server. Below configuration steps for TP-Link TL-WR841N router are shown, but similar steps should be performed for any router.

1. Log in to router's administrative panel.
2. Read MAC address of TV server and its current IP address in the local network. TV server can be distinguished from other devices because its name is *raspberrypi* and its MAC address starts with *B8-27-EB*.

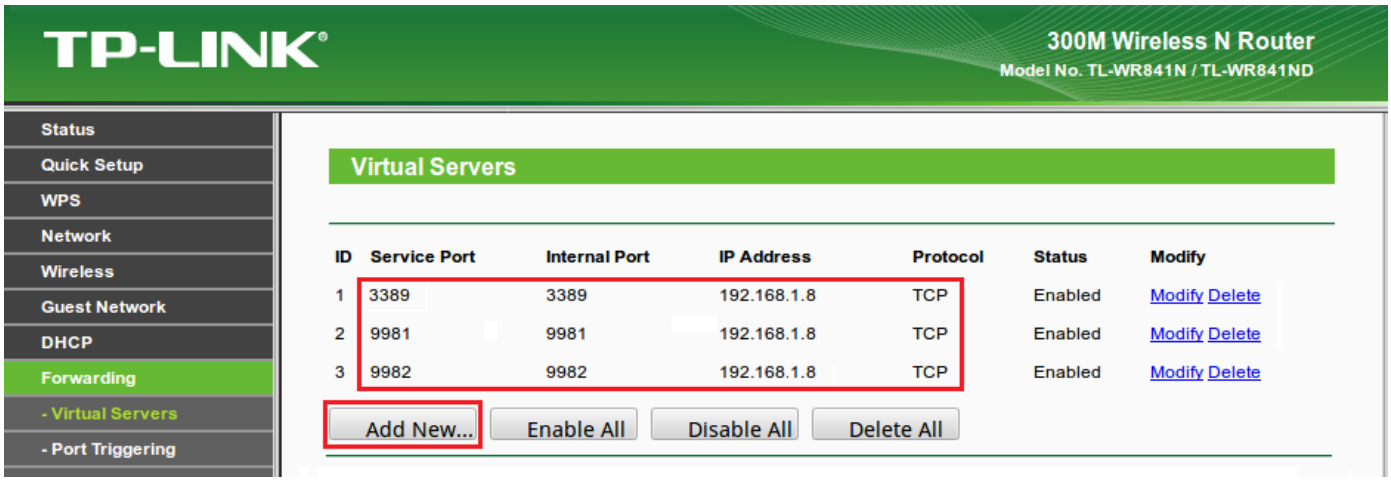


3. Reserve a static IP address on the local network for TV server entering MAC address and IP address read in previous point. Otherwise router will sometimes change local IP address of TV server.



4. Redirect the following router ports to the same ports of TV server with local IP address reserved in the previous step:

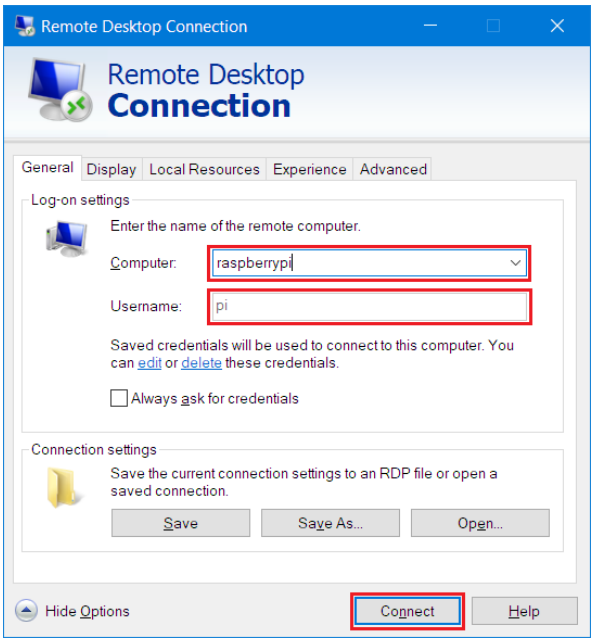
Port	Port function
3389 (TCP)	Remote Desktop (RDP) - configuration of TV server
9981 (TCP)	Tvheadend - configuration
9982 (TCP)	Tvheadend - watching TV



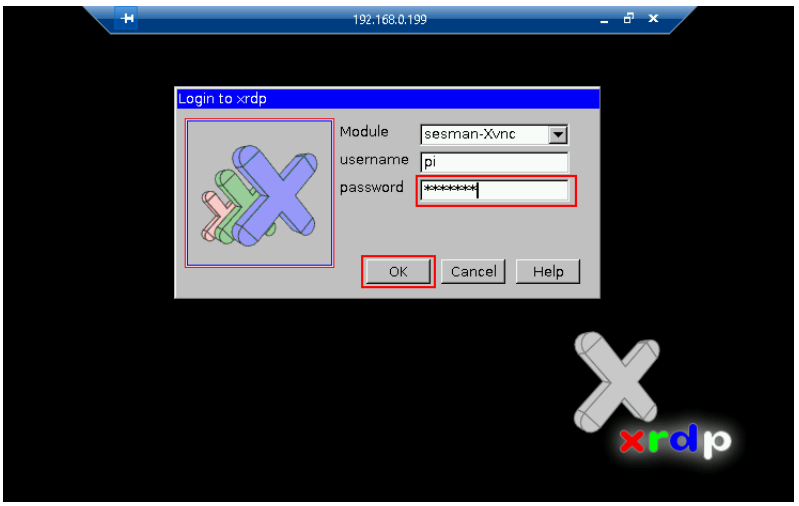
From now you will be able to connect to TV server from external network by giving public IP address of the router instead of IP address of Raspberry Pi. If your router has a dynamic public IP address then constantly changing IP address would be troublesome. In such case use www.noip.com service or similar.

2.3 ACCESS TO TV SERVER OPERATING SYSTEM

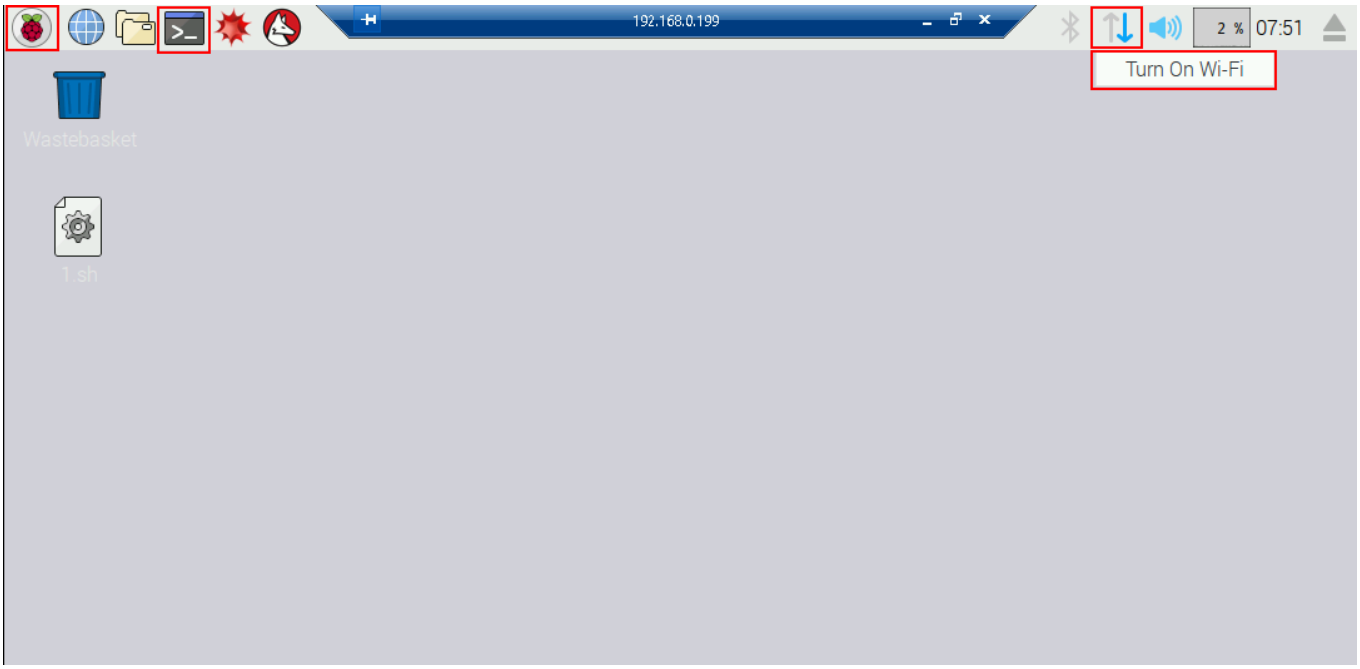
1. Start Remote Desktop client in Windows. Enter *raspberrypi* as computer address, *pi* as user name and press *Connect*.



2. Enter password written on the supplied sheet and press *OK*.



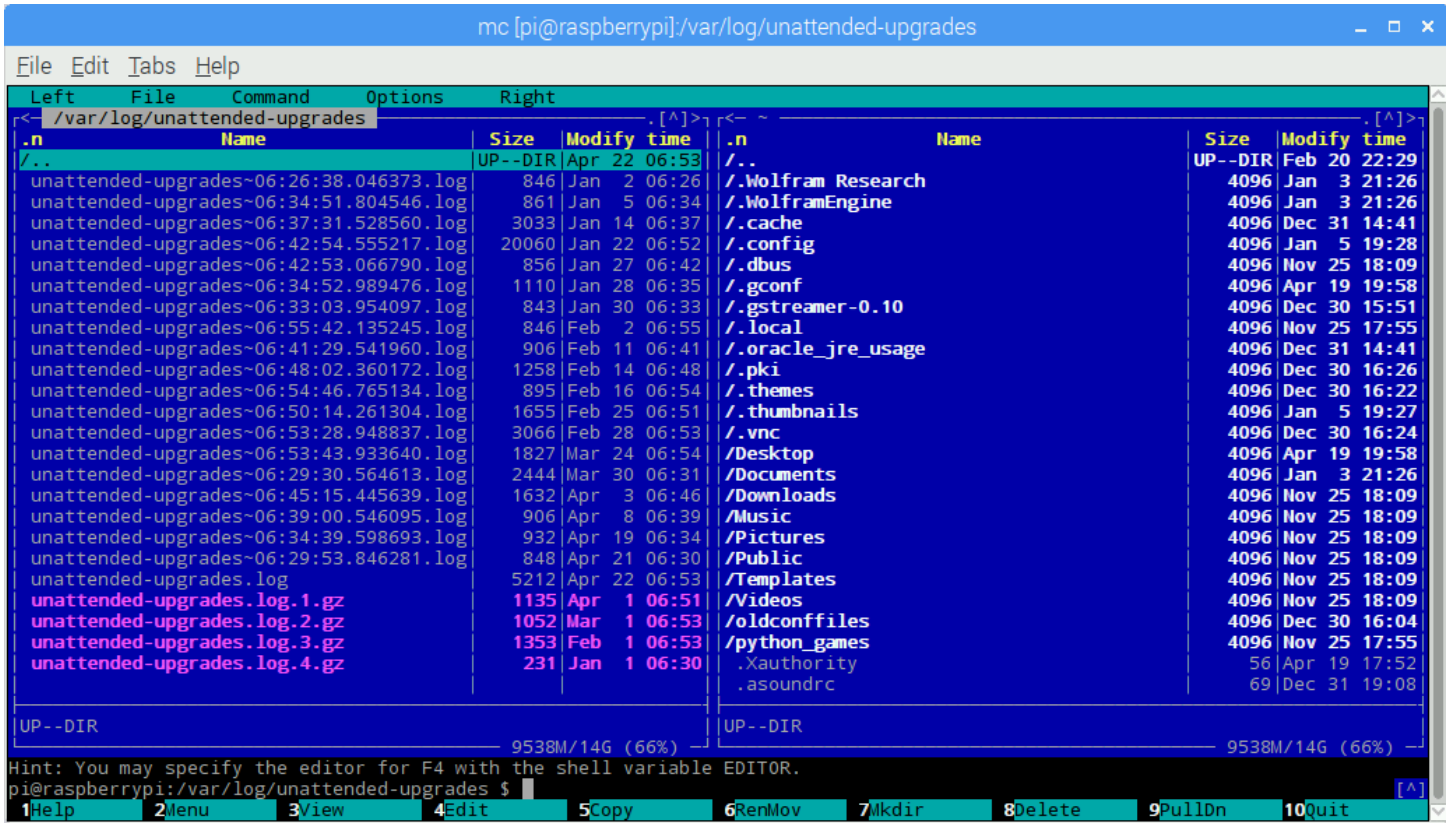
3. You will be logged to server GUI:

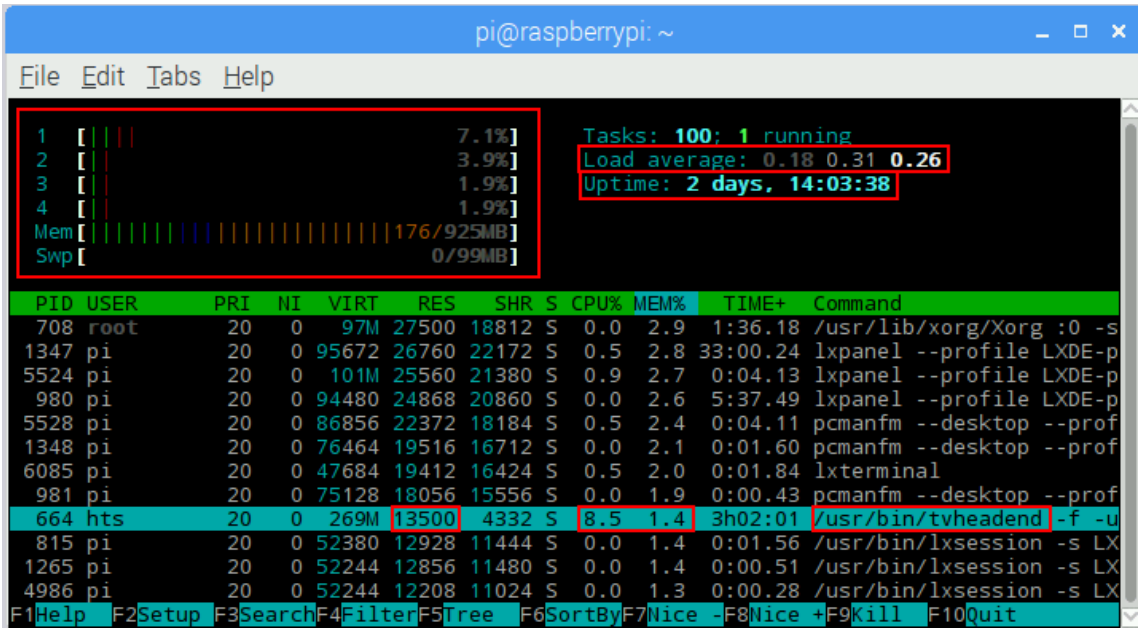


Here you can among others:

- control how to connect to network (by cable or by Wi-Fi)
- check server load e.g. in *htop* console program (to run the program click on *Terminal* icon, type *htop* and press Enter)

- display content of the file system, e.g. in *mc* console program
- check logs of server software automatic updates in */var/log/unattended-upgrades/*.
- turn off TV server in *Menu Start > Shutdown ... > Shutdown*. This is recommended before disconnecting the power from the server.





2.4 TVHEADEND SOFTWARE CONFIGURATION

Tvheadend is a software installed on the TV server that transmits television stream to receiving devices through a computer network.

In your web browser, type http://raspberrypi:9981 address and enter user name *tvadmin* and password written on the supplied sheet.

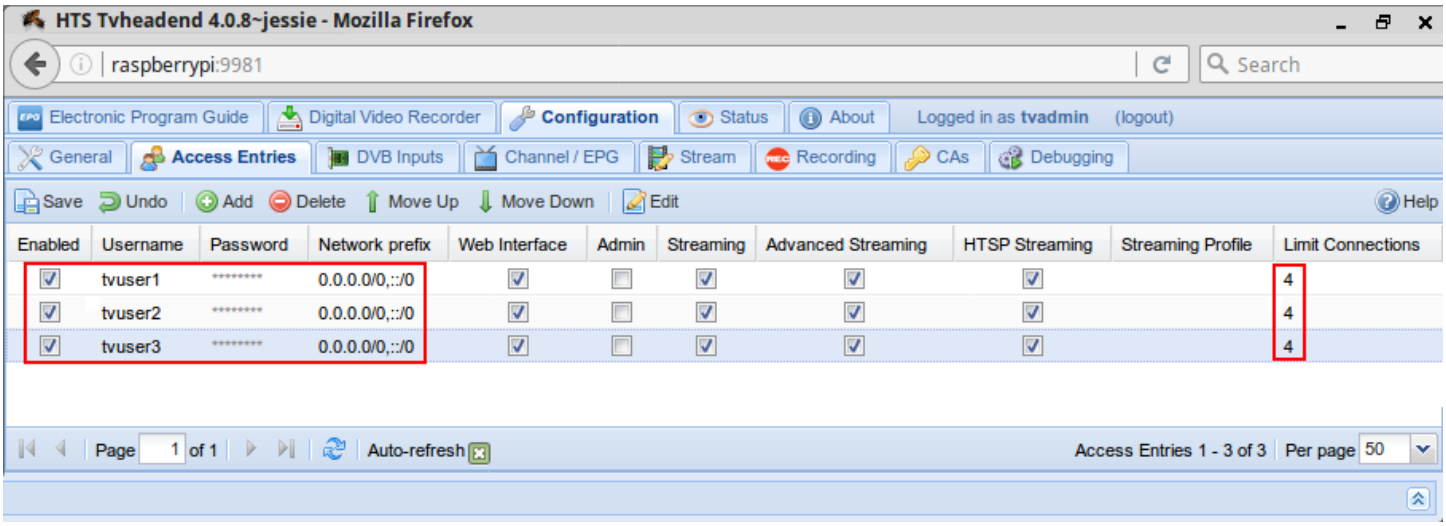
Three tabs are the most interesting:

- *Configuration* - allows you to configure Tvheadend,
- *Status* - allows you to check how TV server works,
- *Electronic Program Guide* - allows you to watch TV from a web browser as shown in the *Quick Start* section.

2.5 CONFIGURATION TAB

2.5.1 Definition of users in *Access Entries* subtab

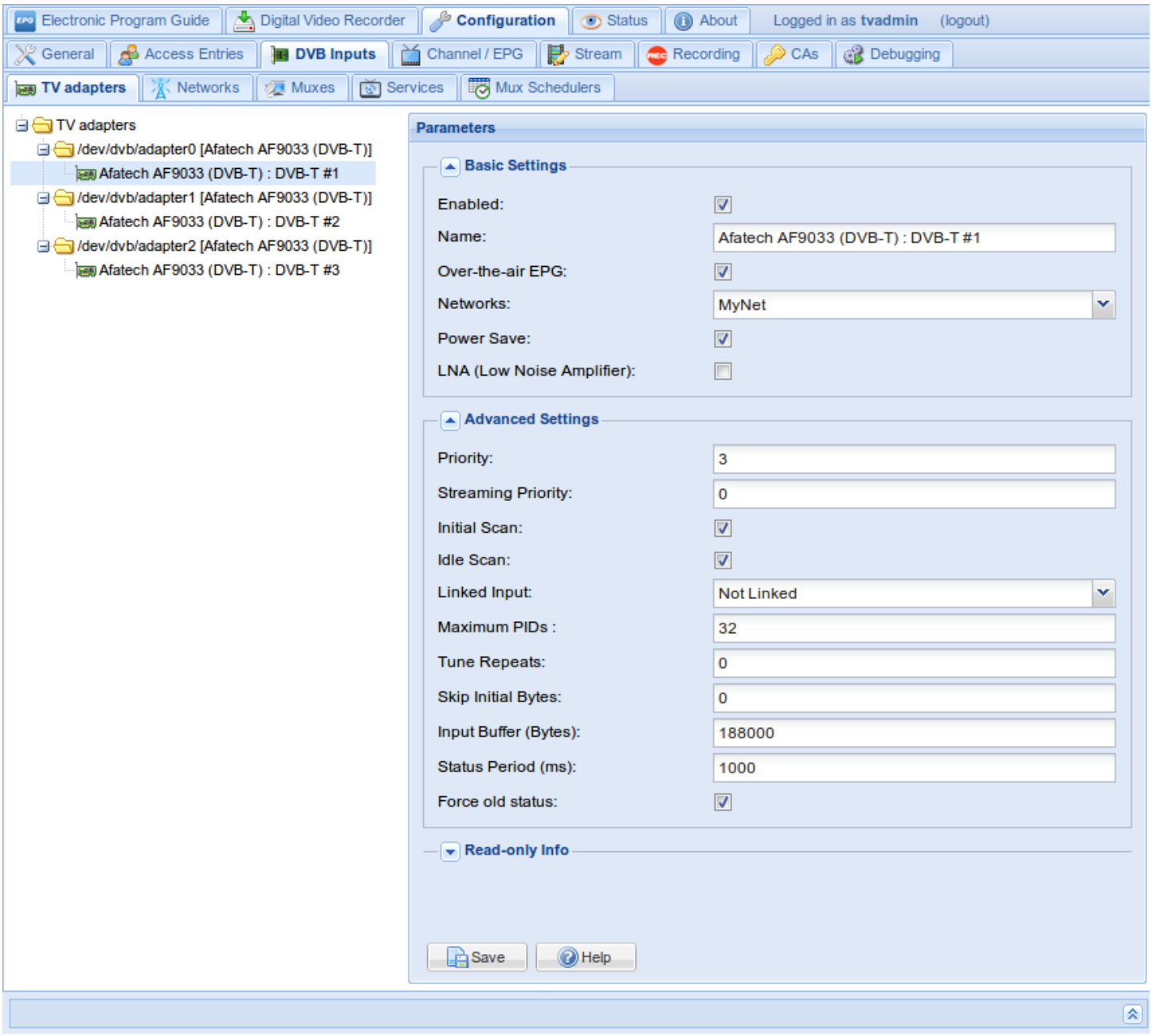
Access Entries subtab allows you to add new users or change parameters of existing users.



Enabled	*yes* - the user has access to TV server
Username	user name
Password	user password
Network prefix	Allows you to restrict access to certain IP addresses: • *0.0.0.0/0,::/0* - access from a computer with any IP address (default) • *192.168.1.1/24* - access from all computers in the local network with IP addresses 192.168.1.* • *a.b.c.d/32* - access only from one computer with IP address a.b.c.d where a-d are numbers from 0 to 255
Web Interface	Allows user to display *Electronic Program Guide* and *About* tabs
Admin	Allows user to display all tabs
HTSP Streaming	Allows user to watch TV in Kodi program
Limit Connections	Maximum number of users with the same name connected simultaneously. Assuming that server needs 6Mb/s upload bandwidth per user, determine the maximum number of concurrent users using the specified name and set it in Tvheadend. If you do not do this and more users will connect to TS server then a problem with the smooth playback of television can arise.

2.5.2 Viewing configuration of DVB-T adapters in *DVB Inputs > TV adapters* subtab

Here is a configuration of 3 DVB-T adapters connected to TV server using USB cables - do not change anything here, unless you know what you are doing.

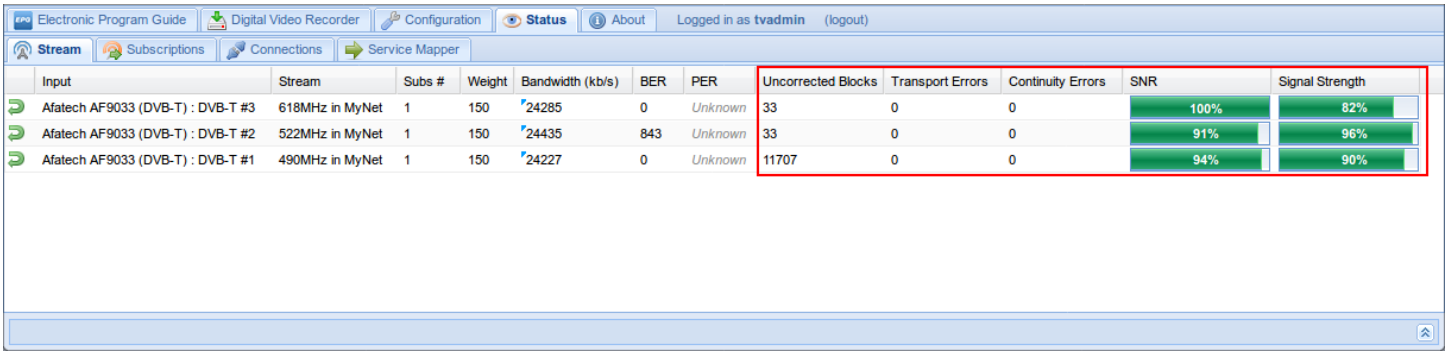


2.5.3 Other subtabs

Other important subtabs are: *DVB Inputs > Muxes*, *DVB Inputs > Services* and *Channel/EPG*. They have been described in the *Quick Start* section.

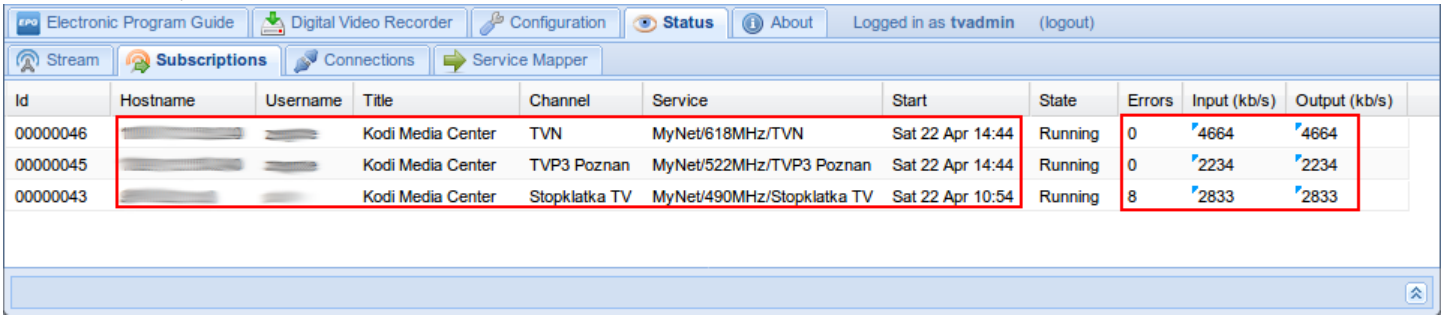
2.6 STATUS TAB

2.6.1 *Stream* subtab



Multiplex streams currently being received from DVB-T adapters (number of streams is equal to number of multiplexes currently being watched); information about: stream bandwidth (in kb/s), number of errors, as well as quality (*SNR*) and power (*Signal Strength*) of the signal from TV antenna

2.6.2 *Subscriptions* subtab



Users currently watching TV with the following information: IP address and name of user, used program (e.g. Kodi), channel being watched, used bandwidth (in kb/s) and errors from the beginning of current subscription if any

To correctly display TV program on the receiving device at least these two conditions has to be met:

- TV signal in the antenna cable need to have an adequate quality. *SNR* should be ≥ 78%. *Signal Strength* is less important and can even be as small as 5%. If *SNR* is too weak then values in columns: *Uncorrected Blocks*, *Transport Errors* and *Continuity Errors* in *Stream* subtab will quickly increase and TV will not play smoothly.
- Network needs to have adequate bandwidth: 6 Mb/s per user for HD channels and 3-4Mb/s for SD channels. If bandwidth is insufficient then values in the *Input* and *Output* on the same line in *Subscriptions* subtab will be different and TV will not play smoothly.

3 WATCHING TV

You can watch TV on your computer, tablet, smartphone and also on TV set with HDMI input by using a smart TV box. Most comfortably is to watch TV in Kodi program. Addition, you can also:

- start TV in a web browser
- on smartphones and tablets start TV in additional programs. This can be useful on smartphones, since using complex EPG in Kodi on a small screen can be problematic for some people.

Requirements

- address of TV server, user name and password provided by TV server administrator
- Internet download speed at least 6 Mb/s for HD channels and 4Mb/s for other channels
- computer, tablet, smartphone or smart TV box strong enough or with the appropriate drivers for H.264 HD video decoding

3.1 WATCHING TV IN KODI

3.1.1 Additional requirements

Operating system:

- Windows 7 or later
- Linux
- Mac OS X 10.8 or later
- Android 4 or later
- other - see kodi.tv/download/

3.1.2 Installing Kodi with TV plug-in

Windows

Download the current version of Kodi installer for Windows (now it is version 17) from kodi.tv/download/, and then install Kodi choosing type of install: Full.

Linux

sudo add-apt-repository ppa:team-xbmc/ppa
sudo apt-get update
sudo apt-get install kodi kodi-bin kodi-pvr-hts

Android 5 or later

On your smartphone or tablet: install Kodi 17 or higher from *Google Play*.
On smart TV box with Android: do not use Kodi 17, because you will have performance problems manifesting by skipping frames and/or pixelation. Instead, install Kodi 16.1 – in cheaper Android smart boxes Kodi 16 works better than 17 (see *Android 4* point below), or install LibreELEC with Kodi 17 (see *Watching TV on a TV set using a smart box*).

Android 4

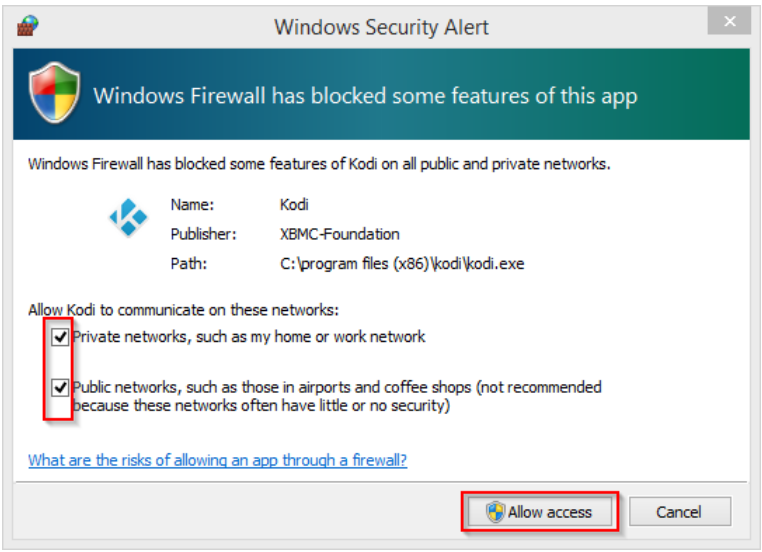
In Android 4.0 and 4.1 you should install Kodi 14.1, and in Android 4.2, 4.3 and 4.4 - Kodi 16.1. To do this, click one of the links above or find a suitable APK file for arm architecture on www.apkmirror.com/apk/xbmc-foundation/kodi/ and then download the installer. Click on the downloaded file in the file manager and install Kodi.
Using Kodi 16 differs from using Kodi 17, so additionally read *Kodi 16* point below.

3.1.3 Configuring Kodi

Note: Kodi starts for the first time in full screen mode. To return to this user guide press backslash ('\') or Alt + Tab.

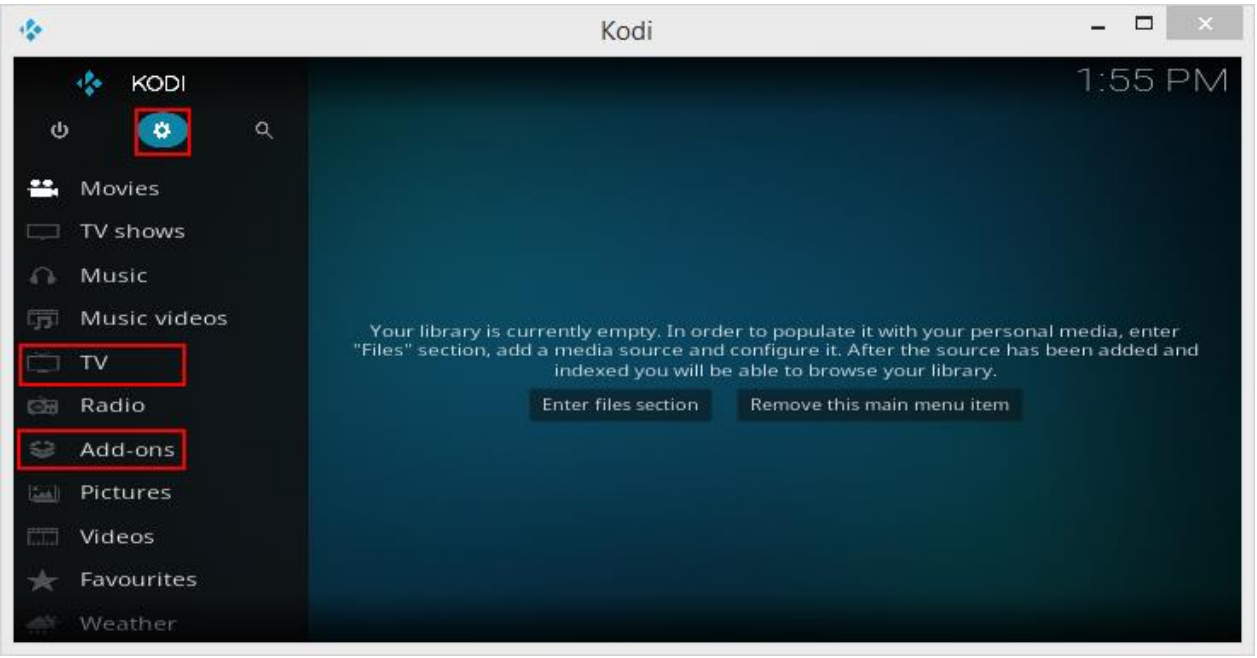
Windows Firewall

Start Kodi. Firewall may ask for permission for Kodi to communicate with network. Allow full communication.



Main menu

Kodi main menu looks like this:



Here you can start its components, for example, television, radio, video player, music player; set up add-ons, or change general settings by pressing ⚙ button in the upper part of the window.

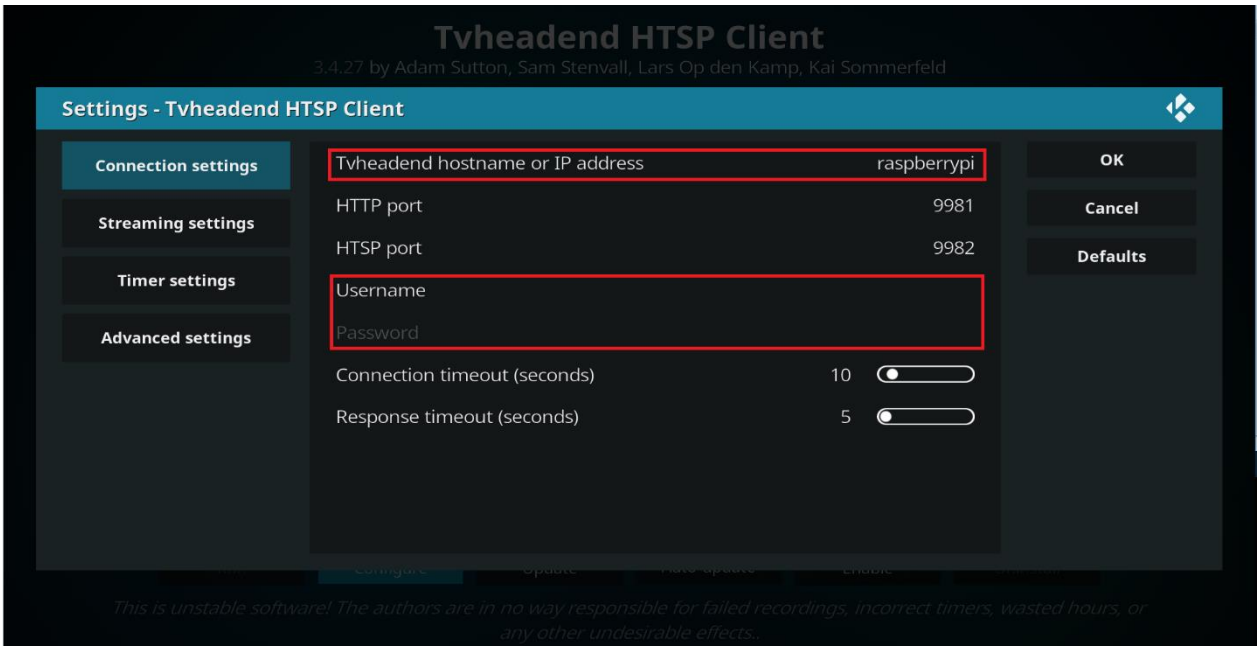
Language

You can change the user interface language by selecting ⚙ *> Interface settings > Regional > Language* in the Kodi main menu.

Connecting to TV server

In the main menu, select *Add-ons* > *My add-ons* > *PVR clients* > *Tvheadend HTSP Client*:

Then press *Configure* and in window that appears in *Connection settings* set the appropriate server address, user name and password provided by TV server administrator:



Press *OK* and then press *Enable* in the parent window. In case of connection errors read *Troubleshooting*.

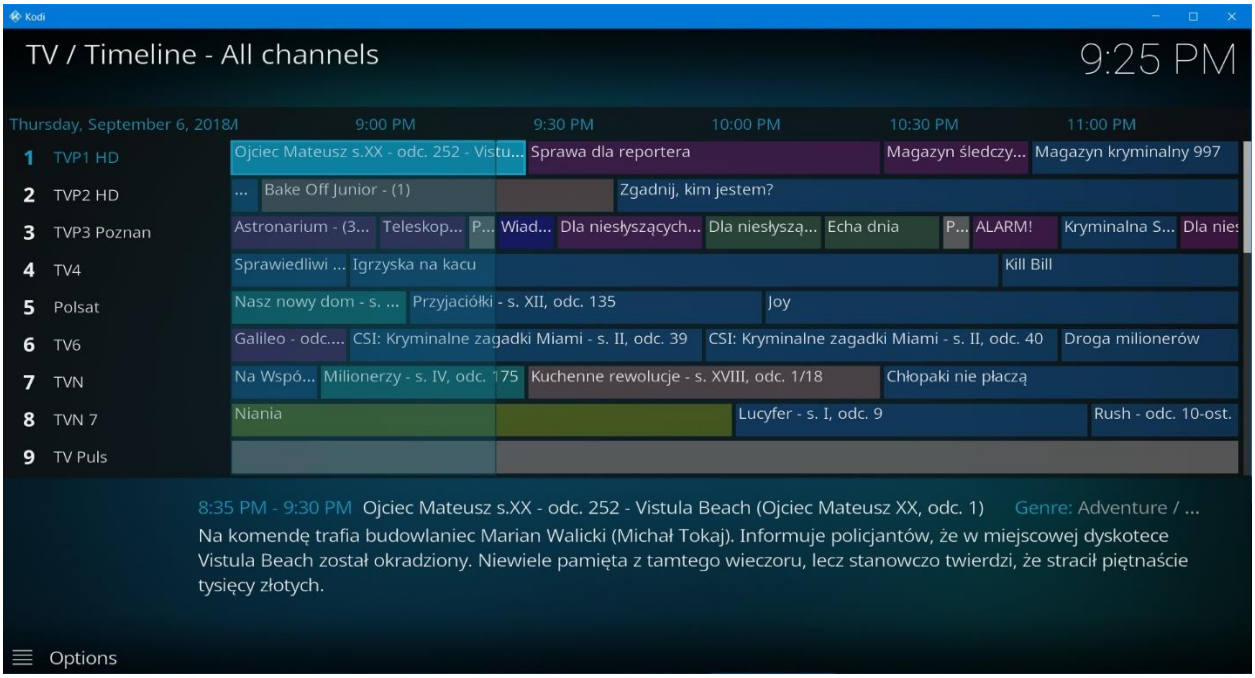
Other settings

To simplify usage press ⚙ button in Kodi main menu and then set:

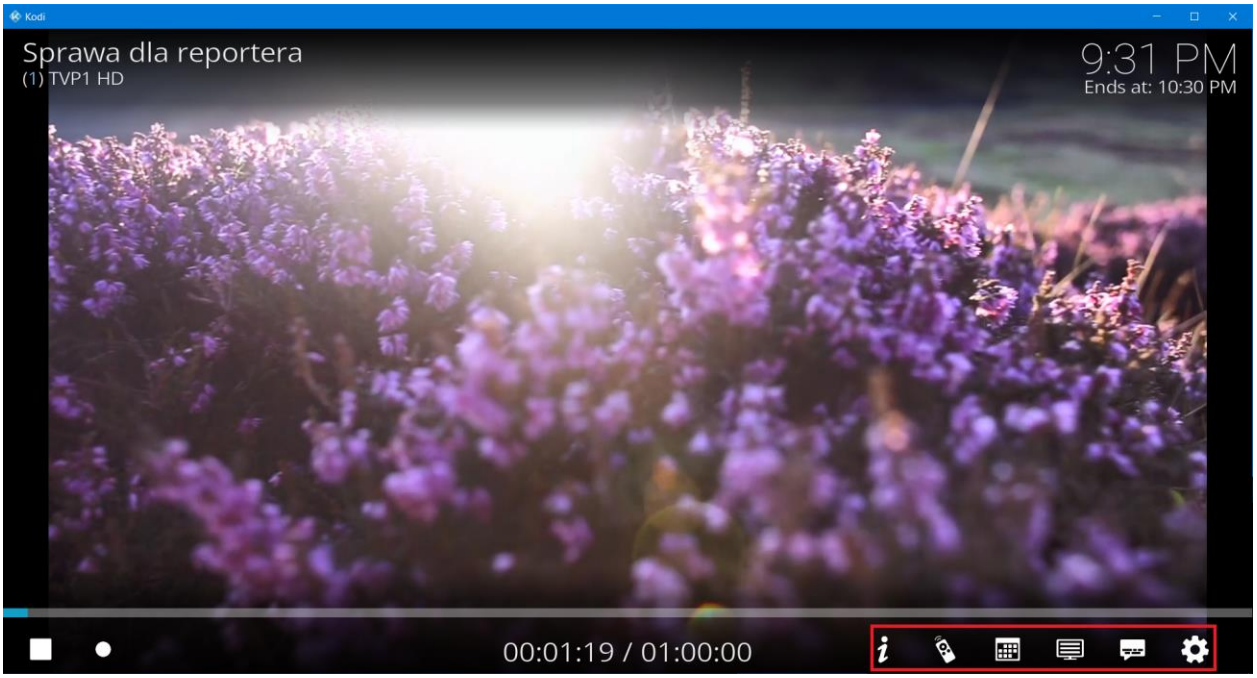
Interface settings > *Other* > *Startup window* = *TV guide*
PVR & Live TV settings > *Guide* > *Default* select action = *Switch to channel*

3.1.4 Using Kodi

Restart Kodi. EPG guide screen will show. You can also show EPG by selecting *TV > Guide* in Kodi main menu.



Select a channel and then press *Enter* key to watch it:



If during watching TV channel you want to change the soundtrack, this can be done by pressing ⊙ button in the lower right corner of Kodi window and then going to *Audio and subtitle settings > Audio stream*. The new setting will be saved.

Controlling

Key on keyboard	Button on the remote controller or in smartphone	Action
Esc	back ↶	Single press shows EPG guide, press it again to display Kodi main menu.
+ and -	equivalent	Changes the internal volume of Kodi.
\	missing	Toggles between full-screen and normal window mode.
O	missing	Shows technical information about TV channel and Kodi. In *PVR info* tab following information is displayed: signal strength, signal to noise ratio (SNR) and frequency of DVB-T multiplex.

By using the buttons displayed in the lower right corner of the screen while watching any TV channel you can:

- preview information about the program that will be broadcasted as the next,
- display subtitles in several languages if available,
- change a language of soundtrack if there are several.

3.1.5 Troubleshooting

Problem: There is a problem with connecting to TV server (so called Tvheadend)

Solution:

Message	Reason	Steps
Tvheadend HTSP Client: Server is unreachable	Wrong address of the server: - a computer with this address is unavailable or - TV software on the server is not responding on the required port	- check address of server, there should be no spaces before it - is Internet available? - can you ping server with this address? - does firewall block communication? - contact TV server administrator
Tvheadend HTSP Client: Access denied	Bad username or password, or Access has been blocked by TV server administrator, or Number of connections allowed for this user was exceeded	- check username and password, are there any spaces before or after user name?, have you entered password correctly? - contact TV server administrator
Tvheadend HTSP Client: No signal	Signal in antenna does not reach TV server or it is too weak	contact TV server administrator
Tvheadend HTSP Client: No free adapters	You cannot watch TV channels on more than 3 different multiplexes/frequencies at the same time	- select a TV channel on a different multiplex/ frequency or wait until selected multiplex/ frequency is available, - ask TV server administrator to limit number of receiving devices to 3 or to remove the most rarely used multiplex/frequency

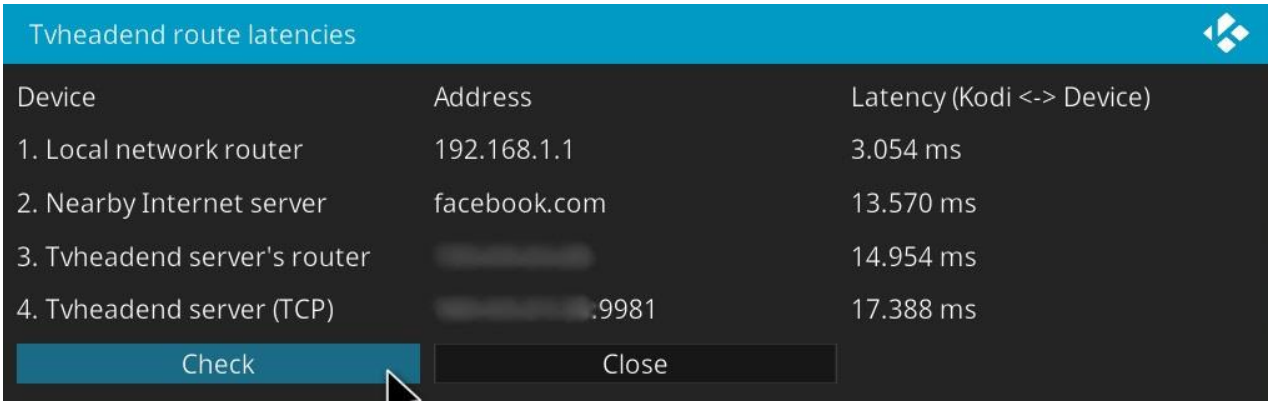
Problem: While watching TV you see horizontal stripes in fast-moving parts of the image.

Solution: DVB-T channels are often broadcast with a so called interlacing. Such channels should be deinterlaced before displaying, otherwise the above-mentioned problem will occur.

If you watch such TV channel, deinterlacing method should be selected in ⚙ *> Video settings > Deinterlace method*: for example, "*DXVA*" in Windows or "*Temporal*" in Linux. If none method is set then set it for current channel and next press *Set as default for all media* to set it for other DVB-T channels.

The above mentioned option is set in Kodi by default.

Problem: TV does not play smoothly

Reason	**Too weak TV signal in antenna cable**	Symptoms	Pixelation, buffering, pauses in stream
Test	Press 'o' while watching TV. In *PVR info* tab SNR must be still ≥ 78%.		
Steps	• Check if television transmitter is not currently serviced. • Contact TV server administrator. Administrator can: check if connector is properly put on antenna cable, replace the antenna, use antenna amplifier or change location of the antenna.		
Reason	**Problem with network performance**	Symptoms	Skipping frames, pixelation, buffering, closing stream
Test	Check pings while watching TV. In Windows: open command prompt, run command: *ping -n 30 TV_server_address*, giving server address obtained from TV server administrator, and read the average time. On average, ping should not exceed 60 ms.		
Steps	• If TV server and computer with TV are in different local networks then install *Tvheadend route latencies* plug-in[2] by going to *Add-ons > Install from repository > Program add-ons > Tvheadend route latencies*, and then pressing *Install*. Then while watching TV launch plug-in by selecting it in *Add-ons > Program add-ons > Tvheadend route latencies*. After 30 seconds you will receive output similar to this:  If pings in 1st step are > 20 ms, this means that the problem is in the local network of receiving device. If pings in 1st step are correct and pings in 2nd step are > 60 ms, this means that the problem is with connection of receiving device to the Internet. If pings in the previous steps are correct and pings in 3rd step are > 60 ms, this means that the problem is with connection of TV server to the Internet. If pings in the previous steps are correct and pings in 4th step are > 60 ms, this means that the problem is in TV server's local network. Similarly, packet loss > 5% in any step is incorrect. If the problem is in receiving device's network then solve it yourself, if it is in TV server's network then contact TV server administrator. In both cases, the following steps are recommended. • Is Wi-Fi network a problem[3]? If problems disappear after connecting device to a router by cable or pulling device up to router then Wi-Fi network is a reason of problems. In such case, connect the device to the router by cable permanently, change Wi-Fi bandwidth from 2.4GHz to 5GHz, change Wi-Fi channel to one that is not used by neighbouring Wi-Fi networks, or use a stronger Wi-Fi network card. • Is sending too many torrents a problem? If so, on each torrent client in the local network limit upload speed and a total number of connections. Does another program or computer use Internet connection excessively? If so, limit the bandwidth available to it. • Test speed of Internet connection on speedtest.net page. During this test TV should be TURNED OFF. Is the speed ≥ 6 Mb/s?		

[2] More information about the plugin can be found at github.com/iwis/script.service.tvheadend-route-latencies.

[3] Problems with Wi-Fi network are more common in the evening than in other times of the day.

Reason	**Problem with receiving device performance**	Symptoms	Skipping frames, pixelation
Test	Press 'o' key while watching TV. In *Player process info* tab usage of each CPU core should not exceed 70% too often, and *HW* should be written in *Video decoder* line. You can also check CPU usage in: ⚙ *> System information > System CPU usage*.		
Steps	• Are there too many programs/processes running? Check in Task Manager if other program is not using too much CPU. Restart computer. • Is hardware video decoding enabled in Kodi? Press 'o'; there should be *HW*, not *SW* in *Video decoder* line in *Player process info* tab. The *Allow hardware acceleration (...)*[4] position in ⚙ *> Player settings > Videos > Processing* should be enabled. If it is turned off then try to turn it on and restart playing TV channel. • Can you play H.264 1080p video in other program on this device, for example in VLC? If you cannot then try to update video drivers. If this does not help, it means that receiving device do not hardware decode TV stream and it is too weak.		

Problem: Video has incorrect width to height ratio (for example in Android)

Solution: Set *Stretch 16:9* in ⚙ *> Video settings > View mode* while watching TV channel which has incorrect ratio. You can press *Set as default for all media* to change this setting for all channels.

3.1.6 Kodi 16

Kodi 16 has user interface different than Kodi 17 - its configuration and use is presented at this point.

Configuration

- In *System > Settings > Add-ons > My add-ons > PVR Clients > Tvheadend HTSP Client* press *Configure*, set server address, user name and password, and then click *Enable*
- Set *System > Settings > TV > General > Enabled* = Yes
- Set *System > Settings > Appearance > Skin > Initial Screen* = *TV*

Using

To watch TV, select *TV* item in menu and then select the channel. Next steps are similar to Kodi 17. *Tvheadend route latencies* plugin is not available in Kodi 16.

[4]To see it you have to show additional Kodi settings. Go to ⚙ *> Player settings* and then by pressing on "⚙ *Standard*" menu item switch it to "⚙ *Advanced*".

3.2 WATCHING TV ON A TV SET USING A SMART BOX

You can watch TV on a TV set or computer monitor with HDMI input. To do this you will need smart TV box, preferably with Amlogic S905X chipset and with LibreELEC operating system as well as Kodi program. We tested watching TV on the following smart boxes with Amlogic S905X chipset:

Label	Smart box	Wi-Fi	Price	Shop
X96	X96	2.4 GHz	€ 35	
M+	MXQ Pro+	2.4 and 5 GHz	€ 53	
B1	Beelink MiniMXIII II 1GB/8GB	2.4 GHz	€ 40	gearbest.com (China)
B2	Beelink MiniMXIII II 2GB/16-32GB	2.4 and 5 GHz	€ 53	amazon.de (Germany), gearbest.com (China)

If you live in a multifamily building and you want to connect TV set to the network wirelessly, then select a dual-band smart box i.e. with both Wi-Fi 2.4 and 5 GHz.

Kodi 17 works correctly only on few smart boxes with Android OS. Thus it is best to install LibreELEC with Kodi 17 on it. Alternatively, you can install an older version - Kodi 16 without changing operating system - see *Watching TV in Kodi* point. Installation and usage of LibreELEC is described below - symbols X96 M+ B1 B2 indicate information applicable to given smart box only.

If you bought a smart box from producer of TV server then LibreELEC is already installed on it and you can omit points 3.2.1 and 3.2.2.

3.2.1 Installation of LibreELEC on microSD card (optional)

1. Connect smart box to TV set according to its user manual.
2. Prepare microSD card with capacity 4-64 GB (4 GB is sufficient) and at least class 10, microSD to SD card adapter and:
   X96 M+ cotton swab with cotton removed from one side
   B1 B2 toothpick that is additionally narrowed on one side with a sharp knife.
3. Download LibreELEC-S905.arm-8.0-8.0.1j.img.gz system image or later - the link is in the first post in forum.libreelec.tv/thread-2156.html thread (press *Older builds* button to see all versions of the image). You do not have to download "device tree" file because smart box has the Amlogic S905X chip.
4. Save the image on the microSD card using program from forum.libreelec.tv/thread-5556.html post.
5. Disconnect the smart box from electricity.
6. Insert the SD card into the smart box (use a microSD card adapter for M+ smart box).
7. Gently insert:
   X96 M+ cotton swab to the socket marked as *AV*
   B1 B2 toothpick to the hole in the bottom of the enclosure
   and press a reset button located at its end. You will hear a click.
8. Connect smart box to electricity while still holding down the reset button.
9. Wait about 10 seconds until you see the LibreELEC logo and then release the button.
10. Wait until Kodi with LibreELEC configurator will start.

In case of problems read forum.libreelec.tv/thread-5556.html post.

3.2.2 Initial configuration of LibreELEC and Kodi (optional)

1. When you see the *Welcome to LibreELEC* window proceed further by pressing the *OK* button on the remote control, and then in the following sections perform the following actions:

Point	**Action**
Interface	press the *Next* button
Networking	Connect a computer network cable or select a Wi-Fi network and connect to it. Press *Next*.
Sharing and Remote Access	press the *Next* button
Thank you	press the *Next* button

2. Install *Tvheadend HTSP Client* plugin. To do this, go to the *Add-ons > Install from repository > LibreELEC Add-ons > PVR clients*, select *Tvheadend HTSP Client* and press the *Install* button. Go to Kodi main menu by pressing *Home* ⌂ button on the remote control.
3. Go to ⚙ *> PVR & Live TV Settings* and then by pressing on "⚙ *Standard"* menu item switch it to *"⚙ Expert"*. This will show additional settings. Then set:
   - ⚙ *> PVR & Live TV Settings > Playback > Show signal quality* = yes, to be able to display information about TV signal in antenna,
   - ⚙ *> LibreELEC > Network > Wait for network before starting Kodi* = yes - when you start a smart box it will wait for a few seconds for a computer network connection.

When you start smart box next time you will no longer need to hold the reset button using cotton swab/toothpick: if the SD card is inserted LibreELEC will start, if there is no SD card - Android TV will run.

We tested that LibreELEC 8.0.1j can be copied from the SD card to the internal memory of each of the aforementioned smart boxes and thanks to it the SD card could be removed from them. The disadvantage is that you probably will lose the guarantee. The aforementioned web pages state that this operation is in general associated with a risk of damaging the smart box, although thanks to the test it seems that it is relatively safe for LibreELEC 8.0.1j version. If you want to copy LibreELEC to the internal memory, do 3.2.3 point before and make sure that you can watch TV properly. Steps of copying LibreELEC to internal memory are described on the aforementioned web pages.

3.2.3 Configuration of LibreELEC and Kodi - individual settings

1. Connect smart box to TV set according to the instructions attached to it.
2. In:
   - ⚙ *> Interface Settings > Regional > Timezone country* set the country you are in - thanks to it local time will be displayed in EPG guide,
   - ⚙ *> LibreELEC > Connections* connect smart box to a Wi-Fi network (or connect the network cable to the smart box),
   - ⚙ *> System Settings > Display > Video calibration...* set size of the screen using arrow keys and pressing *OK*, so that markers are visible in screen corners; press Home ⌂ button; if the settings were not saved set them again
   - ⚙ *> System Settings > Power saving > Shutdown function* set *Sleep* – smart box will turn on faster (optional).
3. Configure Kodi in the way described in *Watching TV in Kodi* section.

Now you can watch TV on smart boxes in the same way as on other devices.

3.2.4 Additional information

- If you have a problem with **strength of Wi-Fi signal** then you can connect the smart box with the router by cable or connect external Wi-Fi 5GHz adapter to smart box USB port.

  D-Link DWA-172 adapter works very well with smart boxes. However, using this adapter, you have to set ⚙ *> System Settings > Power saving > Shutdown function* to *Shutdown*. This will slightly slower starting of smart box - if it will bother you, you can turn off only TV set, leaving smart box always on. Leaving *Sleep* setting will cause problems with connecting to the computer network after waking up from sleep.
- **Displaying information about a TV signal** is more difficult, because there is no 'o' key on remote control which normally displays this information. You can view this information in Kodi on your computer. You can also connect a keyboard to the smart box. Another option is to install *Keymap Editor* addon in which you can set some remote control's button to show this information. To do this:
  - select *Add-ons > Install from repository > Kodi Add-on repository > Program add-ons > Keymap Editor* in Kodi main menu and press the *Install* button,
  - select *Add-ons > Keymap Editor* in Kodi main menu,
  - in consecutive windows perform the following actions:

Window	Action
Keymap Editor	press *Edit*
Select Window to manage shortcuts	select *Global*
Select action category	select *Other*
Select the action and assign a key	Select *Show codec info*
Keymap Editor	press the *Edit* key

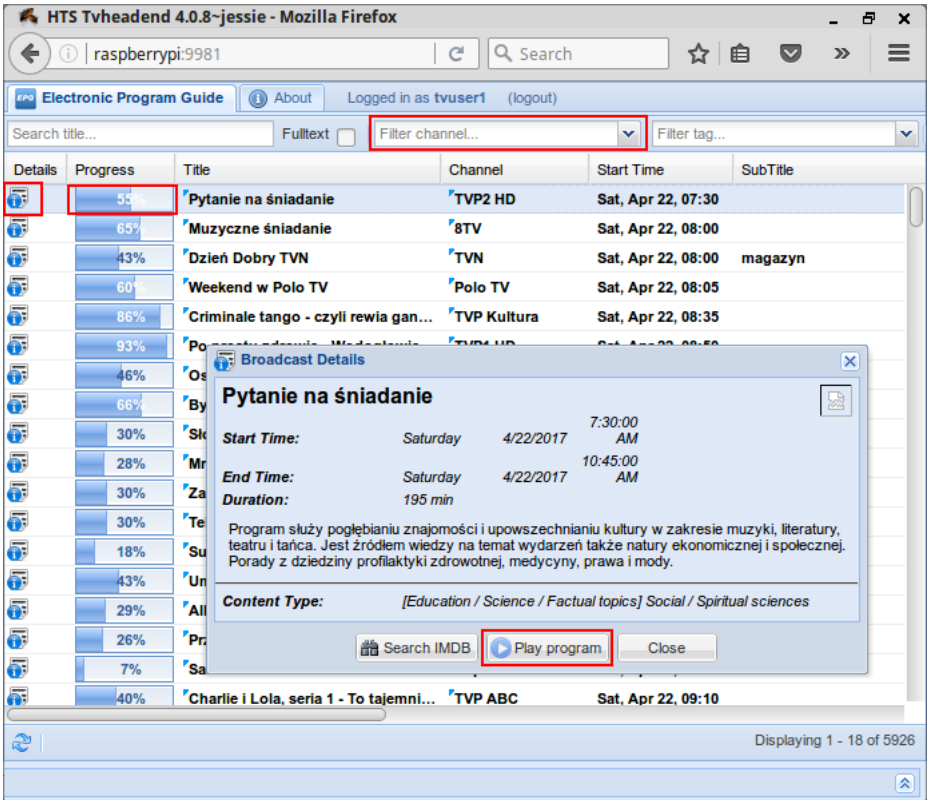
- within 5 seconds, press a chosen button, for example “0”, on the remote control,
- press the back button ↶ three times,
- press *Save* in *Keymap Editor* window.

Start TV channel and press “0” on the remote control. You should see information about the TV signal.

- **Interlacing** is removed automatically – you do not need to set this in the settings.

3.3 WATCHING TV FROM A WEB BROWSER

1. Type http://raspberrypi:9981 address in your web browser and then enter user name *tvuser1* and password written on the supplied sheet. You will see a list of programs.
2. If progress bar appears in the *Progress* column, it means that a program is broadcast on a channel at this moment and you can watch it.
3. Optionally, to narrow the list of programs, you can select the channel which you want to watch in the *Filter channel ...* field.
4. In the *Details* column click on the icon of the program broadcast right now.
5. Click the *Play program* button and open video stream in any video player - for example in VLC.



If you are using VLC then check *Video > Deinterlace > Automatic* item in the menu to remove interlace. In VLC you can:

- change audio track in *Audio > Audio Track* menu,
- display subtitles in *Subtitle > Sub Track* menu.

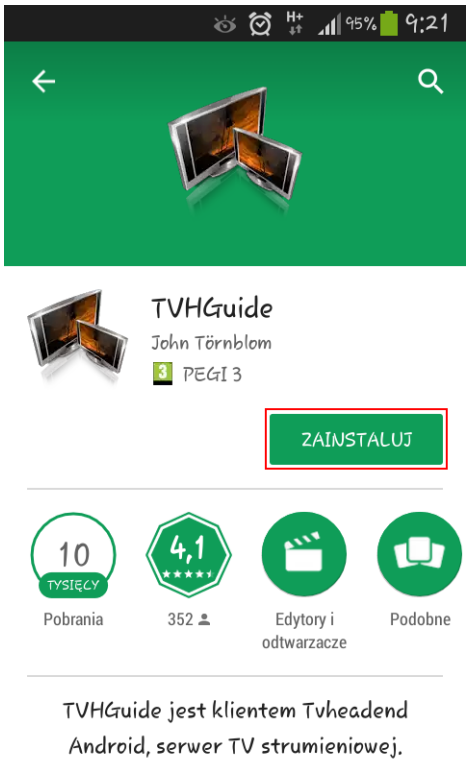
3.4 WATCHING TV ON SMARTPHONE/TABLET WITH ANDROID USING TVHGUIDE

Kodi is a best program for watching TV on Android (see *Watching TV in Kodi*). If smartphone screen is too small for you to conveniently use Kodi interface, you can use additional program - TVHGuide to select a channel you want to watch.

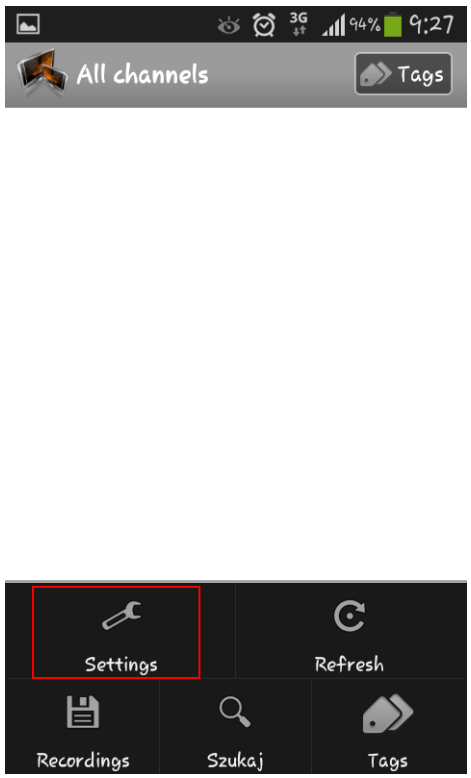
Tested on Android 4.2.2 and 7.0
Note: smartphone/tablet should be connected to TV server using connection with adequate bandwidth (LTE, not HSPA+).

3.4.1 Installation and configuration of TVHGuide

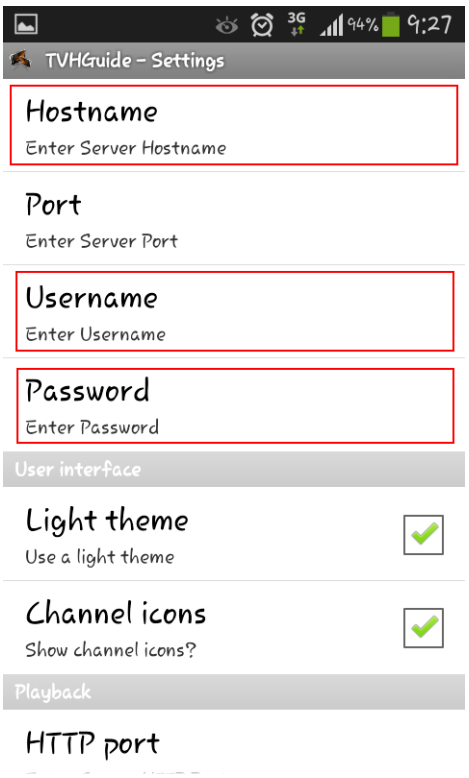
1. Find *TVHGuide* in Google Play store, install it, and then run.



2. Display program menu by pressing the appropriate device's function key, and then go to the settings by pressing the *Settings* button.



3. Enter address of TV server, user name and password that you got from TV server administrator in *Hostname*, *Username* and *Password* fields.



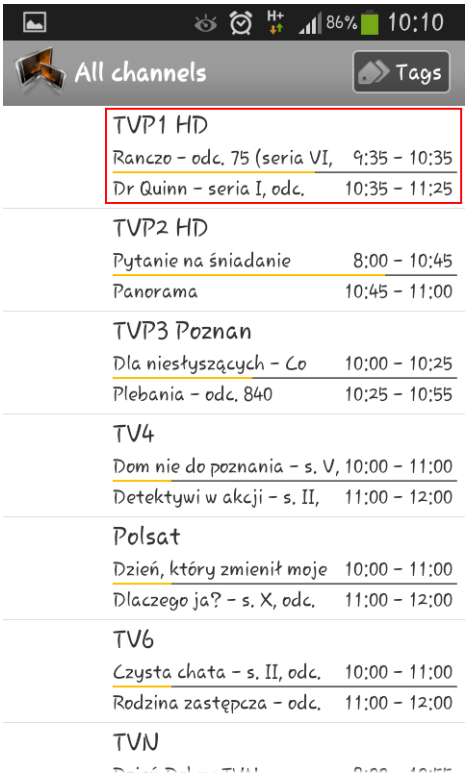
If the configuration is correct, a list of channels will be displayed. In case of errors one of the following messages will be displayed – in this case correct the problem:

sendto failed: EPIPE (broken pipe)	no access to Internet
Can't connect to server or only *Connection timeout*	wrong address of TV server
Access denied	wrong username or password, or access has been blocked by TV server administrator
Server went down	limit of connections available to the user was reached

Additionally, the *Connection timeout* message may display after aforementioned messages.

3.4.2 Using

Press the name of a channel that you want to watch and then press *Play* button.



TVHGuide plays TV in a separate video player program. If a proper program is installed then the selected TV channel will be played in it. If you do not have proper player then install for example:

- Kodi (Android 5 or higher)
- VLC for Android from Videolabs (tested 2.0.6 version) - does not remove interlacing, so it is not suitable for devices with screens larger than smartphone.

and then again press *Play* in TVHGuide.