Theremino **System**

Slots Over Net
v3.0
Instructions

The SlotsOverNet application
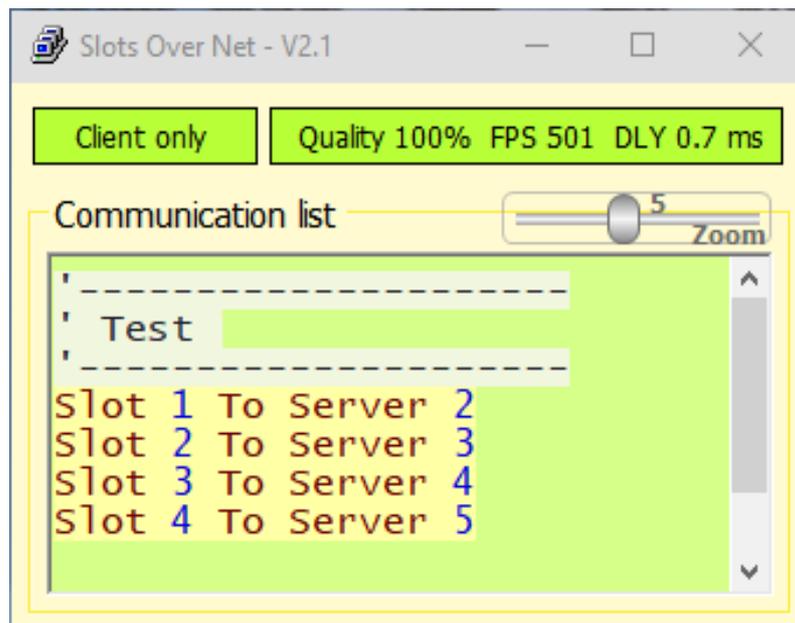
This application connects the Slots of multiple PC in to the local network, via local network, via WiFi, and also through the Internet.

Use this application is easy, no addresses and keywords are required. Just start an application on a computer (as Server) and another on a second computer (as client).

Then they write some command lines, to transfer the values of the slot from one computer to another, and Slots are transferred all at once up to 500 times per second. With a delay of less than a millisecond (on the local network) or a few tens of milliseconds (via the Internet).

The "DLY" delay time is the time it takes for the data to go from the client to the server and then return to the client.

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In *This Page* you will find the SlotsOverNet application. To use it, you download the zip file and unzip it in a folder you like. Then you throw the "SlotsOverNet.exe" file

For this application you have to thank Fabrizio, who was able to make it so simple thanks to its decades of experience on the networks, and now makes available in open source. If you want to write you can be found in *This Page*.

Fabrizio Without this application would not exist. We did not think there could be such an effective, immediate and easy to use.

Until now, to communicate the values of the slots on the net, we had no better that the *OSC protocol* and applications such as MaxMSP. Solutions such complex and difficult to understand, which in practice has never used anyone.

First tests

To learn of this application, we recommend you try using the SlotsOverNet in "Server + Client". To set this method repeatedly pressing the top button on the left, until it appears with the message "Server + Client".

In a special way "Server + Client" using a Virtual Server, which has a memory space her and does not write directly to the PC slot exactly as if it were a server located on another PC.

This is a working method suitable for making tests. It does it all with a single application and there is no need to turn on a second PC.
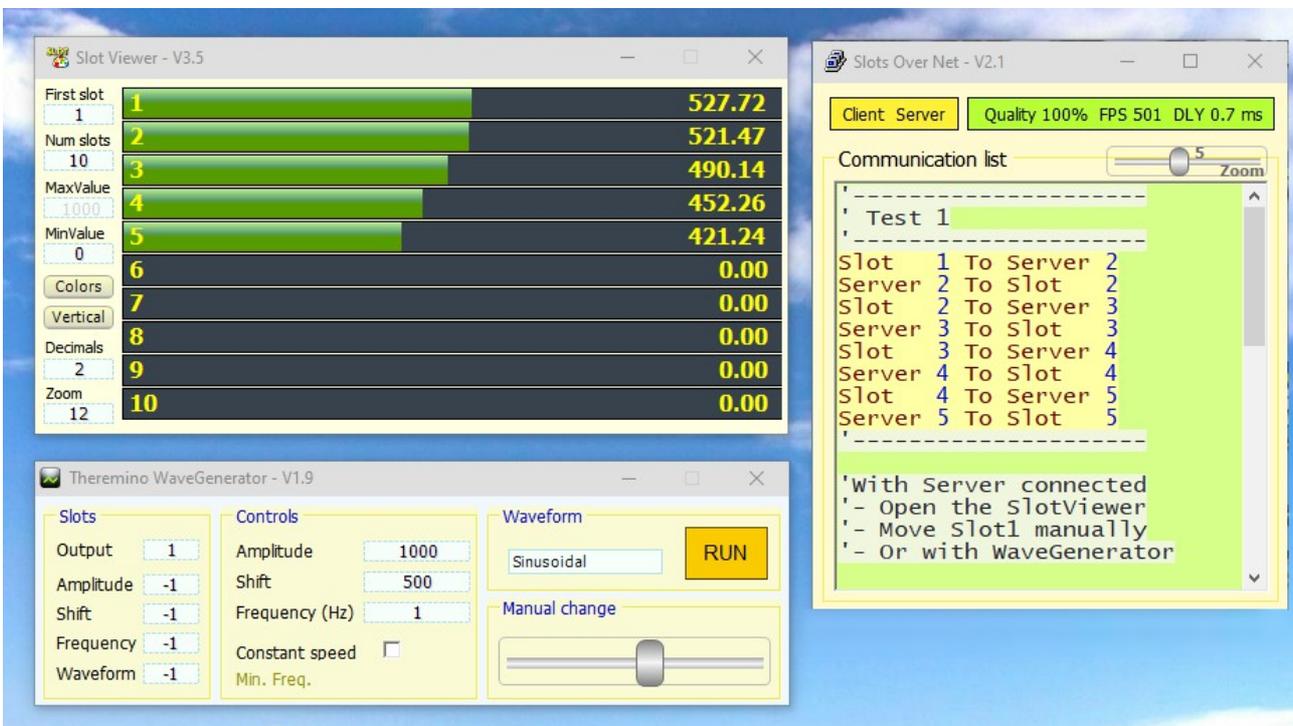
In these tests it is very convenient to use the *Slot Viewer*, To view and edit the values of the slot.

Using the example "Test1", which is present in SlotOverNet just downloaded, you should see the values of 2 to 5 slots that follow the values of Slot 1.

With the SlotViewwer you can manually move the Slot 1 (acting with the mouse on the line "1") and will be seen from the slot 2 to 5 that follow the value of the Slot1.

You can also use the application *Wave Generator*. Adjusting it as in the example image, to automatically move the Slot 1, with sine values from 0 to 1000, at a frequency of 1 Hertz.

Try with "separate Client"

You can do the same tests on the previous page flipping twice and setting the application as a "Server only" and the other as "Client only".
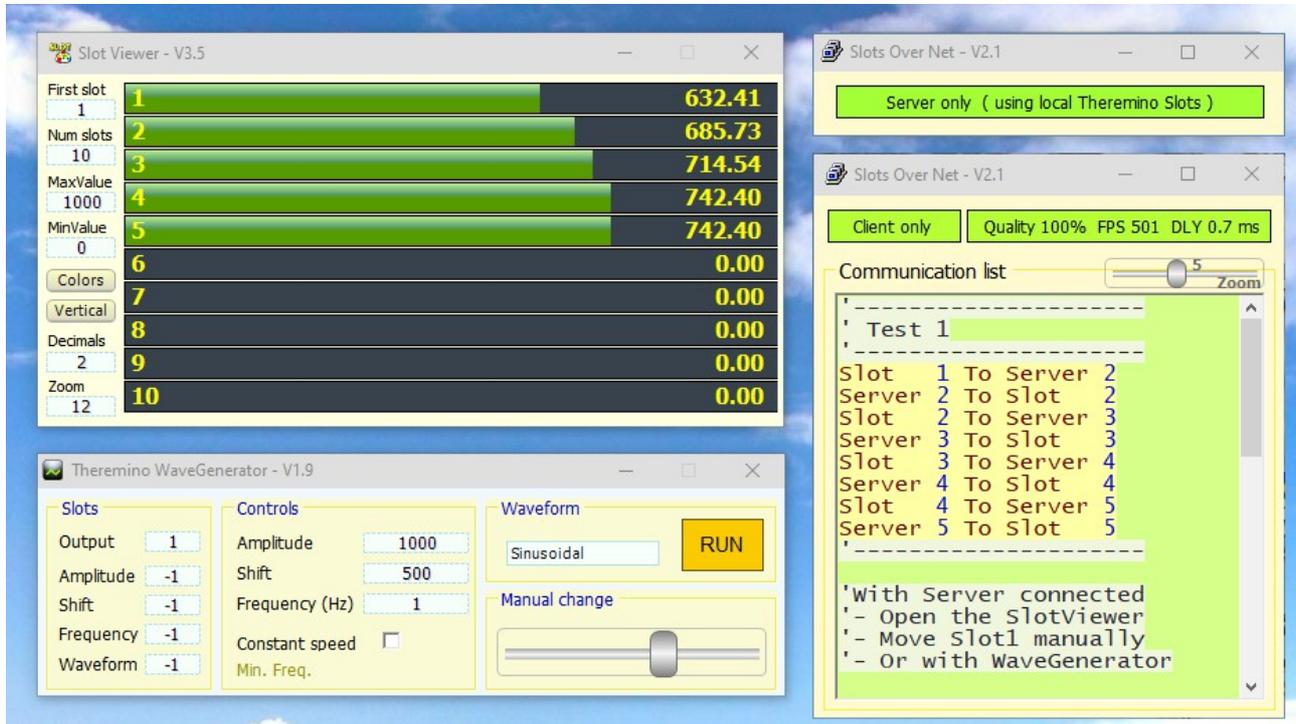
Even in this case you can do the tests without the need to turn on a second computer but there is a substantial difference.

> The Set Server as "Server only" writes directly to the local computer slot.

Then you get the same example operation of the previous page, but just four lines of settings instead of eight.

The "Client Server" operating mode

This is a special way, helpful to make tests on a single computer, Or to make available a server that does not change the local computer slot.

In all other cases using the ways "Server only" and "Client only" explained in the following pages.
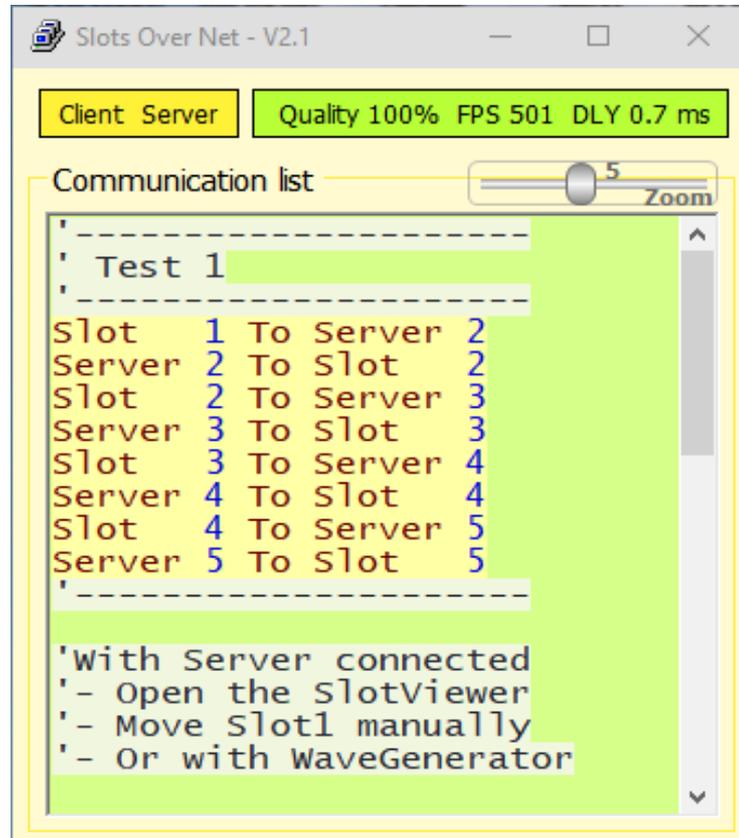
In this mode, the server does not use the slots on the computer, but a kind of virtual slot confined within the application. So you can write and / or read the values in its Virtual slots as if they were the slot located on another computer.

The eight rows of the example of this are just that, transferring data from the local computer and virtual slot on the server, and then transfer them from the Server Virtual slots, slots on the computer.

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In "Client Server" the server is still accessible by clients on other computers. So you can use it to communicate between a computer and the other without affecting the slot on the computer hosting the server.

Wanting to also use the local computer's slot, you can write a few lines to transfer.

The "Server only" operating mode
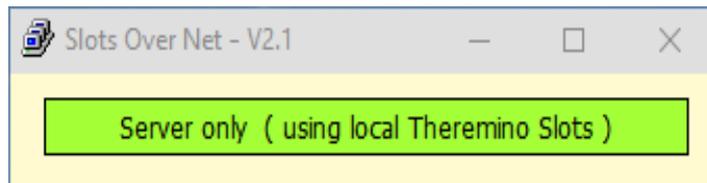
First of all remember that throughout the network there must be a single server.

Then we will start the application, set to "Server only" on one PC, and this app will do to as Server for all other PCs in the network.

Other PC may at any time initiate their clients and transfer their slots to the server or read the Server Slot Slot on their premises.

The "Client only" operating mode
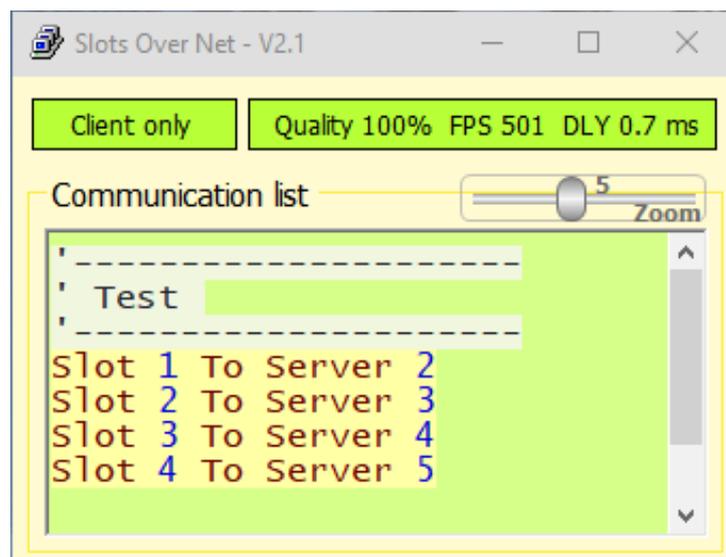
The "client" applications, run on all PCs that do not have Server, transfer the values of their local slots to those of the server and those of the server.

To indicate which slot transfer and in which direction you write transfer command lines, as explained in the next page.

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As always in Theremino system is the rule that one slot can be read by many applications at the same time, it must be written by one application.

If multiple applications write different values to the same slot, there will be a succession of two values and reading the slot will read a random value, or the other.

The command list

Write the commands is easy, the main controls are: "Slot To Server" and "Server To Slot", as in this example.

```
Slot    1 To Server 2
Server 2 To Slot    2
Slot    2 To Server 3
Server 3 To Slot    3
Slot    3 To Server 4
Server 4 To Slot    4
Slot    4 To Server 5
Server 5 To Slot    5
```

The first line of "Slot 1 To Server 2", indicates to copy the value of the Slot 1 building of this PC, Slot 2 on the PC on which the server is started.

The second line "Server 2 To Slot 2", indicates to copy the value of the slot 2 of the PC that is running the server, Slot 2 on the building of this PC.

Copy many slots with a single line

Often you need to copy many consecutive slots, for which there is a special syntax that copies any number of slots by using a single command line.

```
Slot 1 To Server 101 141
```

This line sample copy 40 consecutive slots, from slot 1 up to 41 of the local computer, toward the slot from 101 to 141 of the Server.

Syntax control

The key words are automatically corrected with the initial capital and colored red on a yellow background.

If the line contains errors bottom turns red, otherwise it is yellow as in the examples of this page.

You can write comments preceding them with a single quote and comments may also be to the right of the command lines.

The special commands

Besides the commands to transfer slots you can use the following special commands.

LoopTimeMillisec 1

The right number of this command is a time in milliseconds from 1 to 100. Any higher or lower values are limited and this limitation is highlighted with the orange bottom line. In this case it is good to replace the value with a number from 1 to 100

Normally we use 1 millisecond to transfer the values of the slots as quickly as possible. All Slots scheduled in the list are transferred simultaneously at this time, unless the operating system is able to do so (see the description in the last pages).

In some cases it may increase this time to consume less bandwidth in the network, and load less CPU.
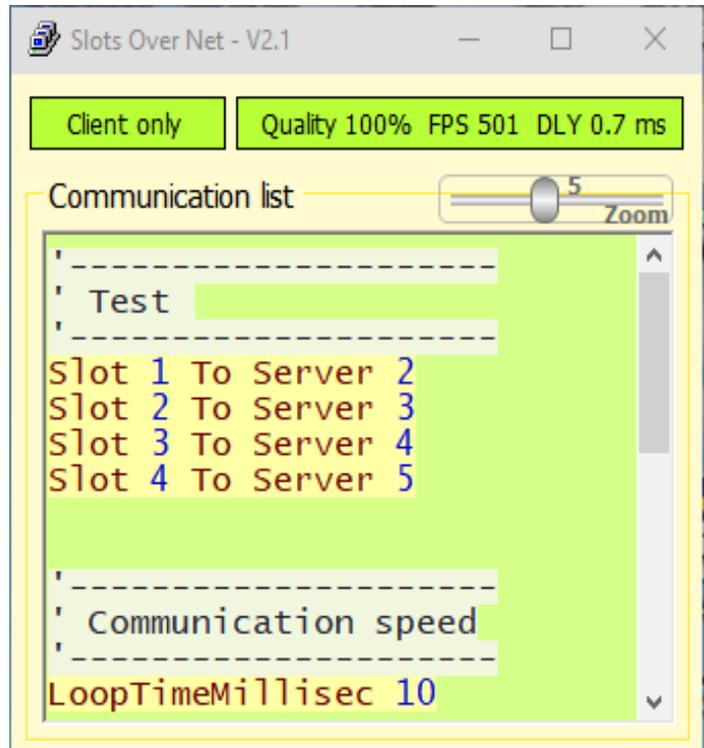
ClientLocalPort 49154

ServerLocalPort 49155

These two commands are used to set the mode doors "Client" and the "Server." Normally they use the ports 49154 and 49155, but you could change them if they are already in use.

WanIpInfo 192.168.99.5 49153

With this command the client locates and connects the server, when the PCs are not on the same LAN.

Default parameters

If you do not use special commands, then the following values are used:

```
LoopTimeMillisec = 1
ClientLocalPort  = 49154
ServerLocalPort  = 49155
```

The WanIpInfo command has not a default value, if not present or commented, then it will not work.

The contextual menu

By clicking on the command list with the right mouse button will bring up the command menu.

The first commands: Cut / Copy / Paste and SelectAll, equivalent to special keys CTRL X / C / V / A, explained below

The last two commands "Comment" and "A-comment", are only available in this menu are used to add or remove the single quote to all selected lines.

With this two commands can be "Comment" or "Uncomment" many lines simultaneously and saves time compared to comment on them one by one.
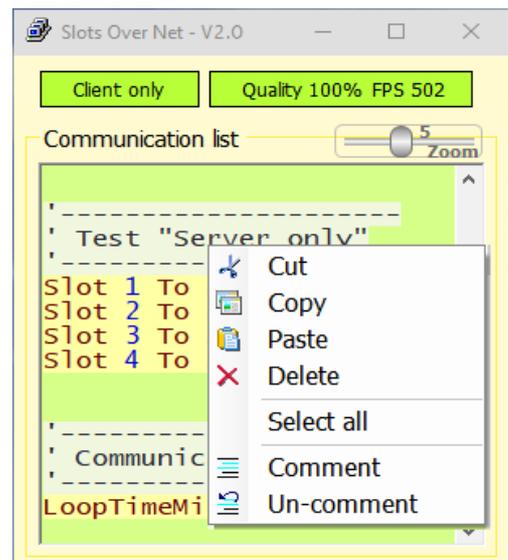
The special keys

To act on the list of commands you can use the following control buttons:

- ◆ **CTRL-X** - Cut (copy and delete) the selected text.
- ◆ **CTRL-C** - Copy the selected text.
- ◆ **CTRL-V** - Paste a previously copied text (from other applications).
- ◆ **CTRL-A** - Select all text.
- ◆ **CTRL-Z** - Execute an UNDO (back to an earlier time).
- ◆ **CTRL-Y** - Perform a REDO (return to a state following after the UNDO).
- ◆ **TAB** - Adds a tab (moves to the right the selected rows).
- ◆ **SHIFT-TAB** - Delete a tab (moves to the left the selected rows).

Possible errors

This error could occur in the following cases:

- If the server has not been started

- If the server is not reachable, for example, because it passes through the WiFi and the signal is weak.

- If the computer that hosts the server has been turned off.
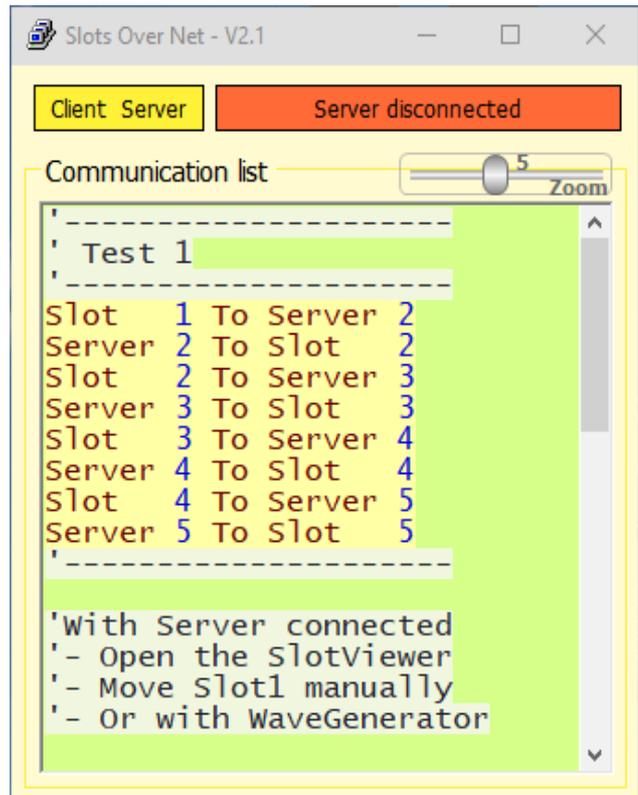
In the network there must be a server, but not more than one.

If you accidentally have launched multiple servers in the same network then you are warned with "Too many servers" message with a number indicating how many.
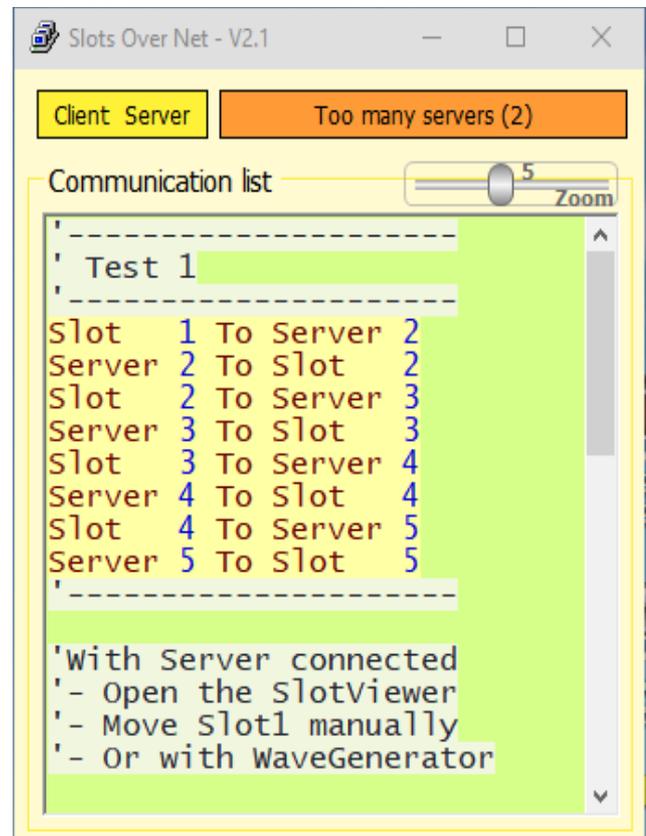
Connecting several PCs

The PCs to be put into communication can be in the same network or in separate networks, possibly also connected through the Internet.

In the following pages we will explain how to use the WanIpInfo command, the IP addresses and ports, and possibly also a VPN.

In all cases only one server will have to be started, on any one of the PCs.
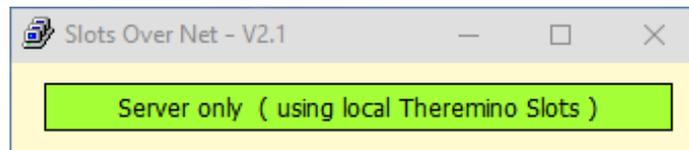
All the other SlotsOverNet applications, one for each PC, must be configured as "Client only".
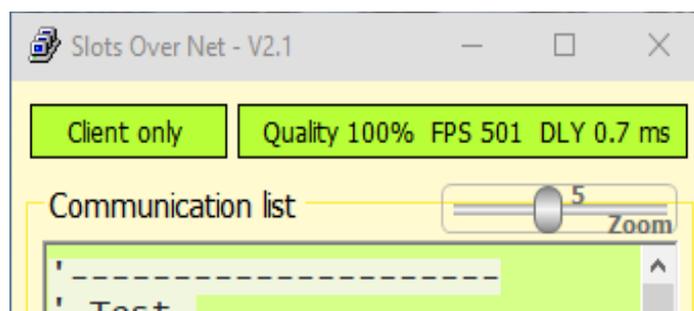
Connecting the Slots via Internet

The SlotOverNet application allows immediate use without the need for configuration when the PCs reside on the same LAN.

If the PCs reside on separate networks, possibly even through the Internet, you have to deal with the router devices that allow them to connect and the relative firewalls that limit, for security reasons, the exchange of data between them.

Exchange Slots through a VPN

Among the numerous technical solutions that allow data exchange over the Internet, a solution could be a VPN that implements a "Mesh with direct connection" type of connection.

This type of VPN allows the various configured PCs to all reside on the same virtual LAN and consequently the instances of the SlotOverNet application can work without the need for configuration.

A convenient solution (and free for up to five concurrent connections) could be LogMeIn's Hamachi.

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For more information on VPN and how to set it up

*refer to the document: **Theremino_VpnHelp**.*

Exchange Slots by setting IP and PORT

Let's assume we have two PCs, one in Turin and one in Milan. Each PC is connected to the Internet through a suitable device (router, etc). In this example we use the default SlotOverNet application configuration values.

We want to swap the slots between the London PC and the Rome PC, so:

- LONDON
  We run the SlotOverNet application in **Client** mode

- ROME
  We run the SlotOverNet application in **Server** mode. Let's assume that the local address of the PC is **192.168.99.55** and that the public IP address (static or dynamic) assigned by the operator to the router internet connection is **87.4.202.52**

These are the necessary configurations:

- LONDON
  To the SlotOverNet application running in **Client** mode we add this directive:
  ```
  WanIpInfo 87.4.202.52 49155
  ```

- ROME
  On the router firewall we configure a **port forwarding** rule to allow UDP packets arriving from London to reach port 49155 of the PC with IP address **192.168.99.55**

Further variations from the basic configuration:

- In LONDON you could have many PCs on LAN running the SlotOverNet application in **Client** mode, all applications must be configured with the WanIPInfo directive and will refer to the Rome **server**.

- In ROME you could have other PCs on the LAN running the SlotOverNet application in **Client** mode; these applications must not have the WanIP info directive configured. They will automatically recognize the only SlotOverNet application present configured in Server mode

*4G connections (smartphone tethering or 4G box): The **SlotOverNet configured as a server** can only be reached if you use an **ADSL, FTTC, FTTH** internet connection, or **mobile networks** associated with the VPN. **Instead the SlotOverNet client always works in every case.***

*Dynamic IPs: all **ADSL, FTTC or FTTH** connections assign dynamic public IP addresses; **home routers also assign dynamic IP addresses to PCs on the LAN**. The connection can stop working if the public or LAN addresses, changing, no longer match those configured on the router and on the configuration of the SlotOverNet Client application. If possible, it would be more stable to assign static IPs for both the LAN and the Internet connection.*

Safety of UDP communications

Local network or Internet

Internet is more vulnerable than the WiFi and wired local network. To increase security on the Internet we use a VPN.

In any case, the greatest dangers are not from hackers, but gaps in speech, human error and hardware and software defects. So, as already written, never use our system to control dangerous or essential equipment.

Cyber attacks

Use this application to install viruses or spy on the data that is on your computer, it is quite impossible. The maximum that an attacker could get is to modify a numerical value. A value that will be promptly corrected within a few milliseconds.

In any case the maximum damage may be to ignite the irrigation for a brief moment, or to know the temperature or humidity orchard. No one is interested in knowing about or changing this kind of data, so normally you can be completely assured.

There would have to worry only if you controllassero appliances that may break, explode, doing damage or be hazardous to the safety of persons.

In these cases, the risks would be many, from the PC that goes crazy to human error, the power failure, the software defects ... well most common dangers and likely of a cyber attack.

Packet loss and communication disruptions

To transfer data at the maximum speed possible to use the UDP protocol and this protocol does not guarantee that packets arrive.

TCP could respond with a confirmation, and in case of error could repeat the transmission. This in our case it would be quite useless, because we repeat the transmission every few milliseconds. And this time is less than the time it would take the TCP to give the confirmation, when added to the eventual re-transmission.

In case of interruptions in communication, even cease the TCP protocol to transfer data. It would also be slower to resume communication, it should come out of a state error, putting the lost packets and then resume communication at regular times.

Technical features

Bytes sent from the client to the server

20 + 8 + 16 + (number of sent slot x 6) + (number of received slots x 4)

Bytes sent from the server to the client

20 + 8 + 14 + (number of received slots x 6)

Details of bytes sent

20 bytes of IP header

8 byte UDP header

16 or 14 bytes of header of our protocol.

Max Slot

In the list of applications you can specify up to 200 slots in total (from the server or from the server).

If you accept a slower and less reliable communication, you can also traferire all Slots, then 999 to the maximum.

Bandwidth Commitment to ask every 100mS if the server is connected

100..110 Bytes / second in transmission

200..300 Bytes / second in reception

Timing of transfers

You can set "LoopTimeMillisec" 1 mS (default) up to 100 mS.

The operating system limits the exchanges to a maximum of about 500 per second, so if you set 1 mS in reality are obtained about 2 mS, and if you set 2 mS in reality they get almost 3.

By increasing the milliseconds timing becomes more accurate.

Delay time

The delay time, which is the send and return time, is less than a millisecond (on the local network) or a few tens of milliseconds (through the Internet).

Even with long delay times it is always possible to send and receive up to 500 packets per second. However, the two data streams will be staggered due to the delay time.

Bandwidth Occupation

Measures based on eight network exchanges, with the following configuration:

```
Slot    1 To Server 2
Server 2 To Slot    2
Slot    2 To Server 3
Server 3 To Slot    3
Slot    3 To Server 4
Server 4 To Slot    4
Slot    4 To Server 5
Server 5 To Slot    5
```

By setting "LoopTimeMillisec" 100 mS
860 Bytes / second transmission
860 Bytes / second reception
total of 1700 bytes / second (approximately)

By setting "LoopTimeMillisec" to 50 mS
1600 bytes / second transmission
1600 bytes / second reception
total 3200 Bytes / second (approximately)

By setting "LoopTimeMillisec" to 20 mS
4120 bytes / second transmission
4120 bytes / second reception
total 8240 Bytes / second (approximately)

By setting "LoopTimeMillisec" to 10 mS
7800 bytes / second transmission
7800 bytes / second reception
total 15700 bytes / second (approximately)

By setting "LoopTimeMillisec" 2 mS
28000 bytes / second transmission
28800 bytes / second reception
total 57600 bytes / second (approximately)

By setting "LoopTimeMillisec" 1 mS
43180 bytes / second transmission
43170 bytes / second reception
total 86350 bytes / second (approximately)