TresnaNet
Musical Generation based on Network Protocols

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ABSTRACT
TresnaNet explores the potential of Telematics as a generator of musical expressions. I pretend *to sound* the silent flow of information from the network.

This is realized through the fabrication of a prototype following the intention of giving substance to the intangible parameters of our communication. The result may have educational, commercial and artistic applications because it is a physical and perceptible representation of the transfer of information over the network. This paper describes the design, implementation and conclusions about TresnaNet.

Keywords
Interface, musical generation, telematics, network, musical instrument, network sniffer.

1. INTRODUCTION
During the 20th century the relationship between art, science and technology has been converging. From *intonarrumori* [5] to the *Brain Opera*, the different scientific and technological advances have changed the art and art has reflected it on their applications and also has found new uses.

The concepts of author, media and audience have changed in this rapid process, from the spectator and the static art object, to the interactor and the interactive art system. These technical and artistic changes can be understood from a new aesthetic perspective that Claudia Giannetti named endoaesthetics [3].

If art, science and technology have always been related, in some of the contemporary artistic productions they converge, dissolving and diluting our previous model of aesthetic experience.

1.1 New environment, rethinking art
Ars Telematica [2] defines in the same concept, all the art created using Internet as a tool. The salient features of this environment (understanding the Internet as a environment) are: connectivity (being online), non-hierarchical and interactive communication, global scale, immediacy (real time), human-machine interaction and body absence (cyberspace, telepresence). These characteristics of the environment, cause that Telematic Art perceives the art as **communication**. Highlighting the importance of communication over the content. We also have to consider two fundamental aspects of the art, **real-time** development and **global scale**.

The nature of their non-hierarchical and horizontal communications model made that Roy Ascott linked the connectionism paradigm with Telematic art. Thus, Internet can be understood as a neural network where the nodes reinforce the connections according to their interests, through their interaction and communication. This network is composed of multiple links and **connections**, such as neurons and connectors form the brain, producing in both cases an asymmetric and specialized connection. [1].

Which brings us to the definition of an art that differs from traditional concepts of author, audience and artwork to focus on interactive models and intelligent systems. Just as the network itself is a system, which provides an open and equal communication between their different nodes, the interactive art provides this same communication between transmitter-receiver-environment.

This is the goal of *TresnaNet*, a sound device that reflects the sound (or silence) of our time (Internet), as *intonarrumori* reflected the sound of the early 20th century, the machines.

2. KNOWING *TresnaNet*
TresnaNet is located as shown in Figure 1 and must be able to connect to the network via Ethernet cable or wireless (if the network offers that option). In this type of network connection, *TresnaNet* should act as a sniffer and monitor all network traffic. This can be a limitation because of the topology of the network.

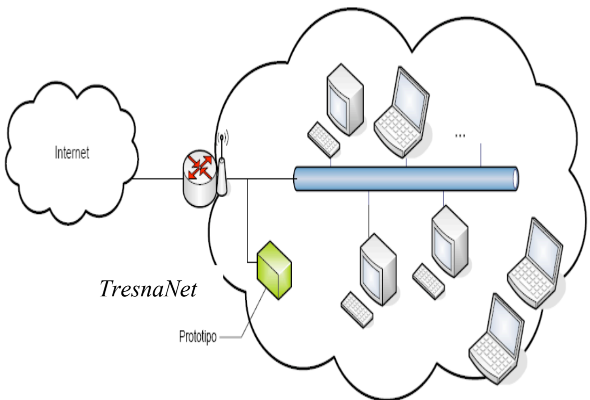

Figure 1. Network diagram that displays the location of TresnaNet.

As shown in the Figure 2, there is an inflow to the system from an external source (network) and an outflow (sound result) that depends on network data. It should consider the possible limitation caused by the type of data from the source, i.e., all flow into *TresnaNet* proceeds from a real time environment, and this stream of constantly changing data will have an impact on the output of the system

2.1 TresnaNet architecture

The desired architecture for the prototype is modular, dividing into layers the different functionalities of the prototype. Various processes are developed within each layer.

Figure 2 shows the intermediate steps between the network (source) and music (output): the physical layer (L1 NTS[1]) connects to the network and performs the extraction of raw materials; it deals with data at the lowest level and informs the user/performer. Secondly, the middle layer (L2 DMC[2]) performs a musical composition or dynamic mapping of data from the previous layer to an upper layer (L3 SG[3]) where musical composition is generated, by using templates of instruments, establishing communication with the user to initiate this process and finally obtain the sound result.

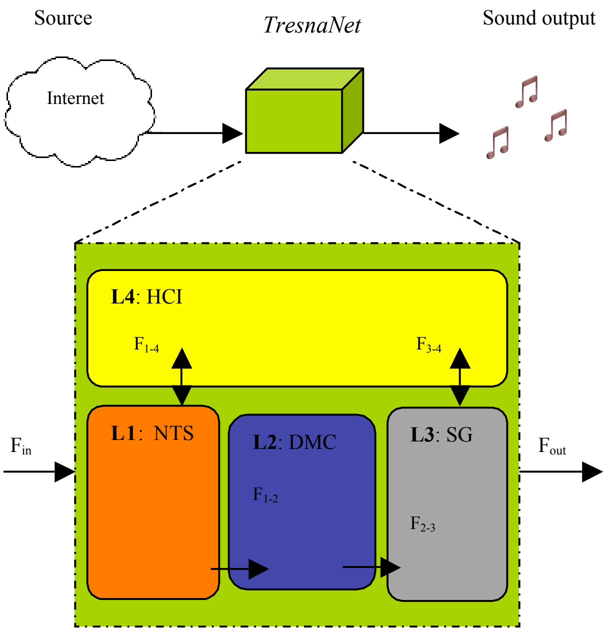

Figure 2. TresnaNet architecture diagram.

In parallel and interrelated with layers 1 and 3, is placed layer 4 (HCI[4]), which give the performance needed by the user for decision-making. The arrows in Figure 2 symbolize the different exchanges of data flows that take place in the system.

3. DESIGN

3.1 Networks and musical process

To access the information that travels and exists in a network must use a network sniffer; each network has similar characteristics and fundamental differences depending on their design, topography, servers, use, etc. To achieve an appropriate model for *TresnaNet*, we need to delimit the wide range of possibilities of using this information (traffic, raw material) and be able to understand this raw material extracting what interests us.

3.1.1 Raw material

A LAN[5] can be wireless or wired; therefore, to avoid limitations, *TresnaNet* extracts data from the network layer up. Among these data, can be highlighted: different protocols (network and transport layers), the routing of the packets (port mapping) and IP addresses.

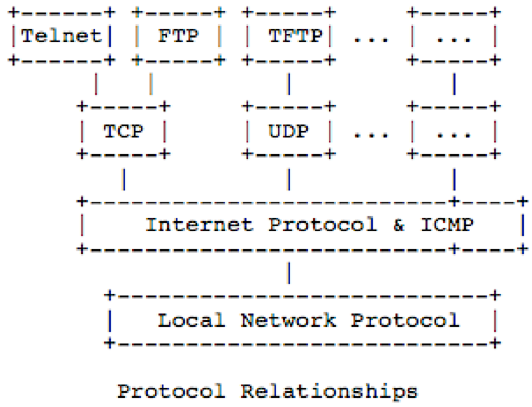

Figure 3. Protocol relationships from RFC 791.

3.1.2 Sound typology

What defines an Internet connection? What characterizes the traffic? How can we make equivalences or find a pattern?

Network traffic can be translated musically as a sound traffic noise with different characteristics, which refers to Schaeffer's idea of musical object [6]. But like everything, depends on the perspective of observation. If we want to define this traffic more generally, the object itself is equivalent to traffic, but if we want to highlight the features as a detail, each of them could be a musical object.

The reality is that network traffic is not made up of absolutely different objects, in other words, they have dependencies between them and what characterizes the traffic, for example in packet level, can be encapsulated into another one (TCP/IP levels).

Therefore, we can talk about the Matryoshka model or Russian doll, but repeatedly, as analogy. Thus, would have a set of objects with certain intersections or other typical operations of set theory. It is directly linked to the object-oriented programming and its distribution in classes and the methods of each of them.

Extrapolating back to a musical parallelism, data from network traffic provide a series of sound patterns (sets of objects); those can be understood as musical instruments (samplers) and may even resemble the mechanism of a synthesizer [4].

From there, TresnaNet create libraries of objects. In addition to the collections, must take into account certain global variables (featuring the network) that affect the characterization of the sound.

Some equivalences sound - telematics have been made during the development of TresnaNet, they are described in Table1.

[1] Network Traffic Sieve

[2] Dynamic Musical Composition

[3] Sound Generation

[4] Human Computer Interaction

[5] Local Area Network

Table 1. Sound – telematics equivalences

Sound features	Telematic equivalence
Reverb	Each time a network packet is created, a counter increases the number of packages and its number, influences the sound reverb.
Sound pan	The distribution of sound in space (L / R) depends on whether they are received or sent packets (i.e., if IP's that are maintaining a connection are repeated, these sent or received packets are distributed between left or right speaker).
Oscillators	The frequency is oscillated according to the resonance base. Used ports or the packet-length average defines the harmonic basis.
Rhythm	Based on the number of TCP/UDP packets type.
Specific sounds	Some specific services at the application level trigger certain sounds to make them recognizable. For example: - Trigger some sound effects on templates if port 80 is used. - Differentiate some web consulting, according to its IP: Facebook, Youtube, Hotmail, etc.
Sound repetitions (notes, sounds)	According to the IPs that sniffer detects.

3.2 Layer design

3.2.1 L1 NTS: Sniffer

Usually, this software is provided with a graphic interface for an easy view of data (packets) and decodes them. In this case, TresnaNet does not need a graphical interface, but the real-time capture and extraction is essential. Carnivore[6] performs this function. Processing fully integrated (it is a library) and exists the option of develop a specific *TresnaNet* sniffer, mapping data from the network into variables which are later sent to PD. Also because:

- It is Open Source.
- Captures, filters and transmits raw packets.
- Provides statistics.

[6] http://r-s-g.org/carnivore/ Developed by RSG. [Accessed, April 2008]

3.2.2 L3 SG: Pure Data[7]

Musical synthesis, either analog or digital, starts from scratch in sound generation. *TresnaNet* uses PD for layer 3, because of the following features:

- Open source and multiplatform.
- Communication with other software through OSC[8]
- Patches modification in real time.

3.2.3 L2 DMC and L4 HCI

TresnaNet uses Processing[9] as programming platform because it allows:

- Transmission by OSC with PD.
- To capture and to monitor sniffer data and customize it.
- To make a GUI with great interaction.
- A future communication with Arduino.

4. IMPLEMENTATION

TresnaNet made the extraction of network data through Carnivore; this network data reading is received by Processing. The program implemented, makes the mapping of these data, to pass through OSC to Pure Data, where sound generation happens. Using certain functions, the performer/user can interact with the artwork /*TresnaNet* through Arduino.

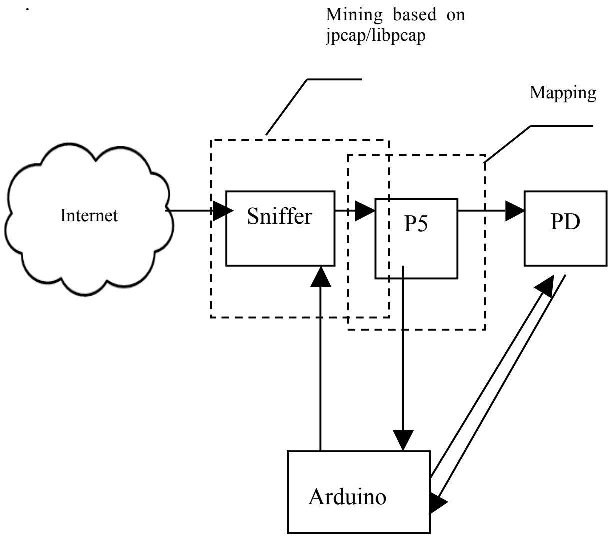

Figure 3. TresnaNet design diagram.

4.1 Processing

A modular logic is used to develop the code, in other words, different sketches for each feature:

- Sniffer: A customized Carnivore client has been developed to extract the desired data from the network packets and send them to PD.
- OSC communication: L2 sends messages to L3. IP must be defined and also the transmission received/sent port. In each message, a tag and a value must be assigned for PD interpretation.

[7] Henceforth PD. http:// puredata.info/ [Accessed, April 2008]

[8] Open Sound Control, http://opensoundcontrol.org/ [Accessed, April 2008]

[9] http://www.processing.org Processing [Accessed, April 2008]

- GUI[10]: designed to be as intuitive as possible from the start, made up of various buttons functionalities (sending some parameters of the network, trigger PureData, etc.) scrollbars for volume and ability to display network data. The classes are for buttons and scrollbar creation. And `method helpers` for displaying text on screen.

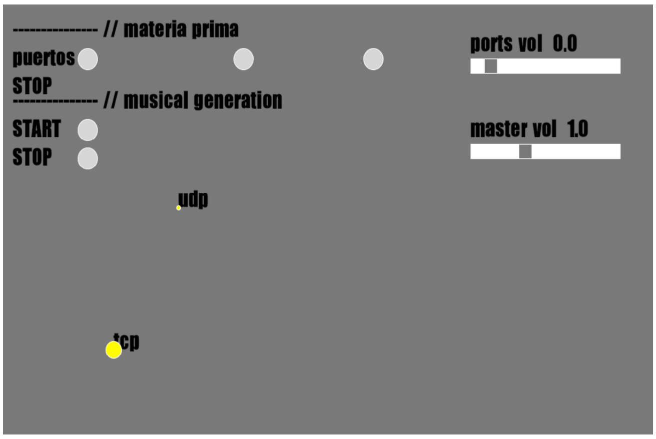

Figure 4. TresnaNet GUI screenshot.

4.2 PD Patches

An OSC client is implemented in the PD main patch in order to receive the data provided by Processing and to load the libraries that allow communication with OSC.

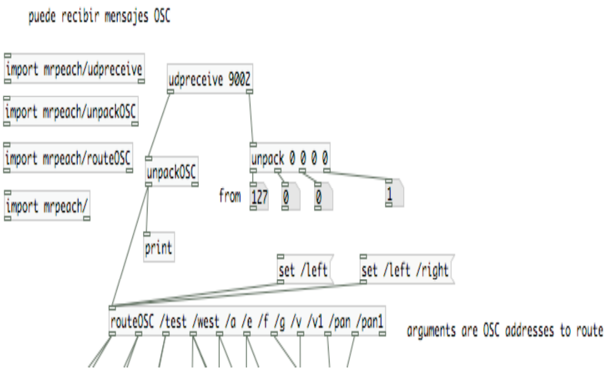

Figure 5. PD patch screenshot.

Also specify the UDP port where OSC packets are waiting, as shown in Figure 5. `RouteOSC` object provides the addressing of the arguments to our PD subpatches.

5. OUTCOME

5.1 Future research

HCI improvement. Currently all user interaction is through a graphical interface created with Processing. But the second phase of development of *TresnaNet* foresees the possibility of control by Wiimote. In addition, it is also planned to develop a controller using Arduino.

Evolve from a software gadget to an independent musical instrument. The above improvement is directly linked to it. If carried out, it should reconsider the *TresnaNet* architecture, considering the needs of processing (which are high) and interaction.

Thanks to this improvement, the user interaction (interpreter) or listener of the work would be more complete. The similarity to a traditional musical instrument would facilitate the understanding of the use and potential of *TresnaNet*.

Musical ensemble formed by different networks. Possibility of creating an installation would give the option of playing with several *TresnaNets* located on the same network or on remote networks.

Layer 1 utilization. As well as doing the extraction of the dedicated data to the musical composition, it also could route other data to visual generation. With this improvement, *TresnaNet* becomes into an audiovisual generation tool based on network protocols.

Research on Sound - Telematics equivalences. Continue to develop this model of equivalence and sustainable develop a theory of musical characterization.

5.2 Conclusions

The intersections between art, science and technology have been and are a reality, even now a necessity. The emerging art forms feed off the advanced technologies. In a society where being unconnected is beginning to look like science fiction, the understanding of the medium (Internet) is basic and telematics as a tool, can facilitate new forms of expression.

The way we communicate has changed in a few years, also the art, concepts as artwork, author, spectator, have mutated to pass to the interaction, leaving the mere spectator back. Similarly, the Web 2.0 is more than a reality; any design should be guided by these characteristics of change, interaction, and creation of own content, a great example would be the Reactable and in another level, this work.

TresnaNet can have an educational and artistic use, because it is capable of displaying or make sound the silence of existing networks, making perceptible the amount of data that travel around us and customize them.

6. REFERENCES

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[5] Russolo L. *El arte de los ruidos.* Centro de Creación Experimental de la Universidad de Castilla-La Mancha. Cuenca, Spain, 1916.

[6] Schaeffer, P. *Tratado de los objetos musicales*. Alianza Editorial, Madrid, 1966.

7. APPENDIX

Soon all the documentation and music generated by *TresnaNet* in the iMiLab website[11].

[10] Graphical User Interface

[11] *impossibleMusicalinstrumentsLab* [underconstruction] http://impossibleinstruments.com