WINDRUM:

A PROGRAM FOR THE CONTINUOUS

SEISMIC MONITORING

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Overview

WinDrum is developed on Windows platform, written in Visual Basic, with a small Fortran code compiled as DLL (Dynamic Link Library) for the decoding of the data packets. It is a program for the continuous monitoring of a single seismic channel signal designed to substitute the classical paper drum monitor. It allows displaying of 24 hours of a seismic signal, by designing a given number of graphical pages. The trace can be zoomed. From the "zoom window" the duration magnitude (M_D) can be obtained by mouse clicking the earthquake's onset and the coda-end time. WINDRUM optionally creates a binary file (DAY format) that contains all received data of a day. This file is useful to redraw the data if the program is temporarily stopped and can be used by other programs to print the data on paper. WINDRUM periodically (es. each 30 - 40 s) can generate a BMP file of the current graphical page, call an external procedure to convert BMP to GIF or JPEG format and copy them to the WEB server saving the previous pages so that the user can have graphical files related to the last 24 hours available for HTML pages and WEB applications. The data are transmitted to the program in the TRACE_BUFFER format, an Earthworm (www.cnss.org/EWAB) data type, by UDP protocol. At present only i2 (Integer X 2) data type are managed. A new release, compatible with all the Earthworm TRACEBUF structure data type will be available in the next future. In order to monitor several signals, it is possible to run the program in multiple copies on the same computer. Each signal will be displayed on a split single monitor, on a whole multiple monitors configuration or in a combination of both the cases. The program is tested using a single monitor on Win95, Win98, Windows2000 and NT. The multi-monitor configuration is only tested with Win98. If more then one WinDrum program are running on machines of the same LAN network, the operator, can choose to broadcast some actions, as the time picking or the signal window zooming, to all the active WINDRUM modules. If two or more WINDRUM programs are run on the same computer one copy of the program will act as master and the others as clients, depending on the setup parameters. This solution allows to supplies the data to all WINDRUM by sending the data packets to a single port on the LAN, using a broadcast UDP transmission. Each master program will take care to redirect in "localhost" the data packets to the client programs, selecting them on the base of the clients station and channel name contained in its setup file.

THE USER INTERFACE

In the fig. 1 is shown the WINDRUM user interface. It is composed of the following elements:

- A large picture box, showing a graphical page with a continuous seismic signal of a given number of hours. The other graphical pages, for a total of 24 hour, are in background. They can be moved to foreground by mouse clicking the labeled buttons at the top of the windows. It is possible to zoom a signal segment by mouse clicking the trace. At the first click a label with time will appear and at the second one a new window will appear (Fig.2), showing the zoomed signal. If pressing the right button after the first click the selection will be removed.
- A bottom left side picture box showing a given number of seconds of the incoming signal.
- A "Menu" command button to call a "Menu Form" (Fig. 3).
- Two scrolling bar to set the gain in both the graphical controls.
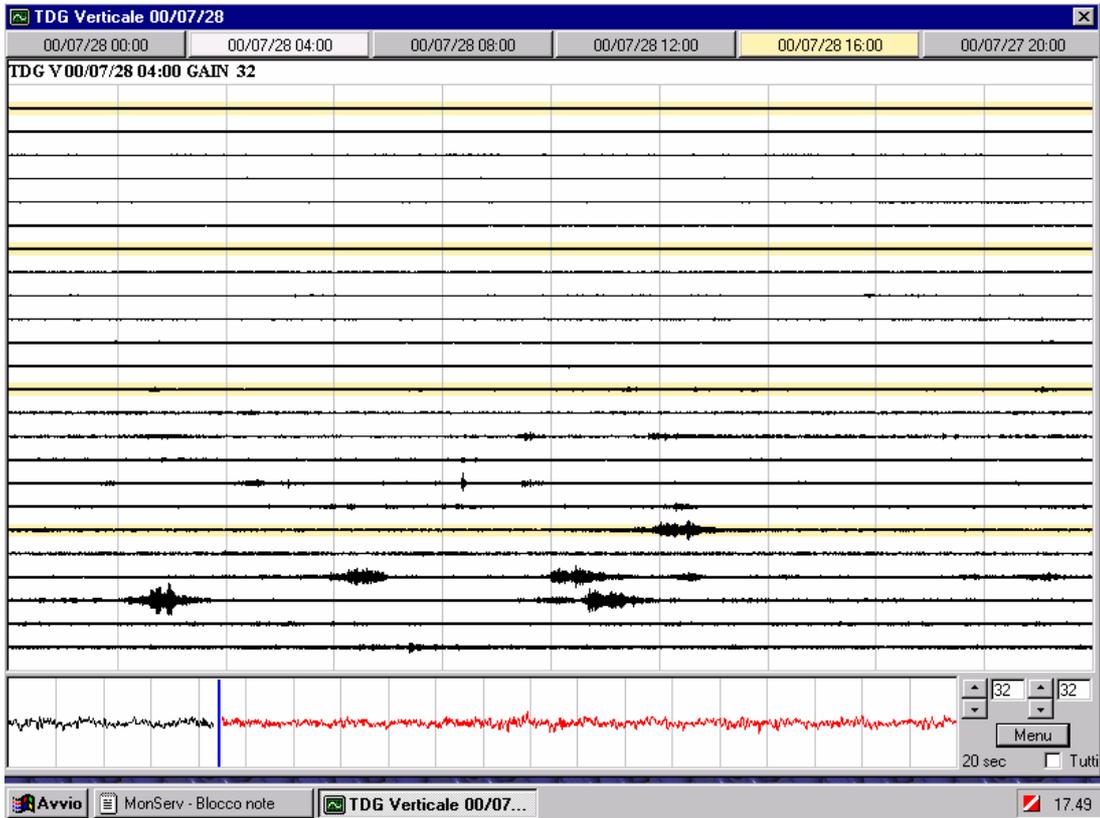- A check box to enable the broadcast command sending.

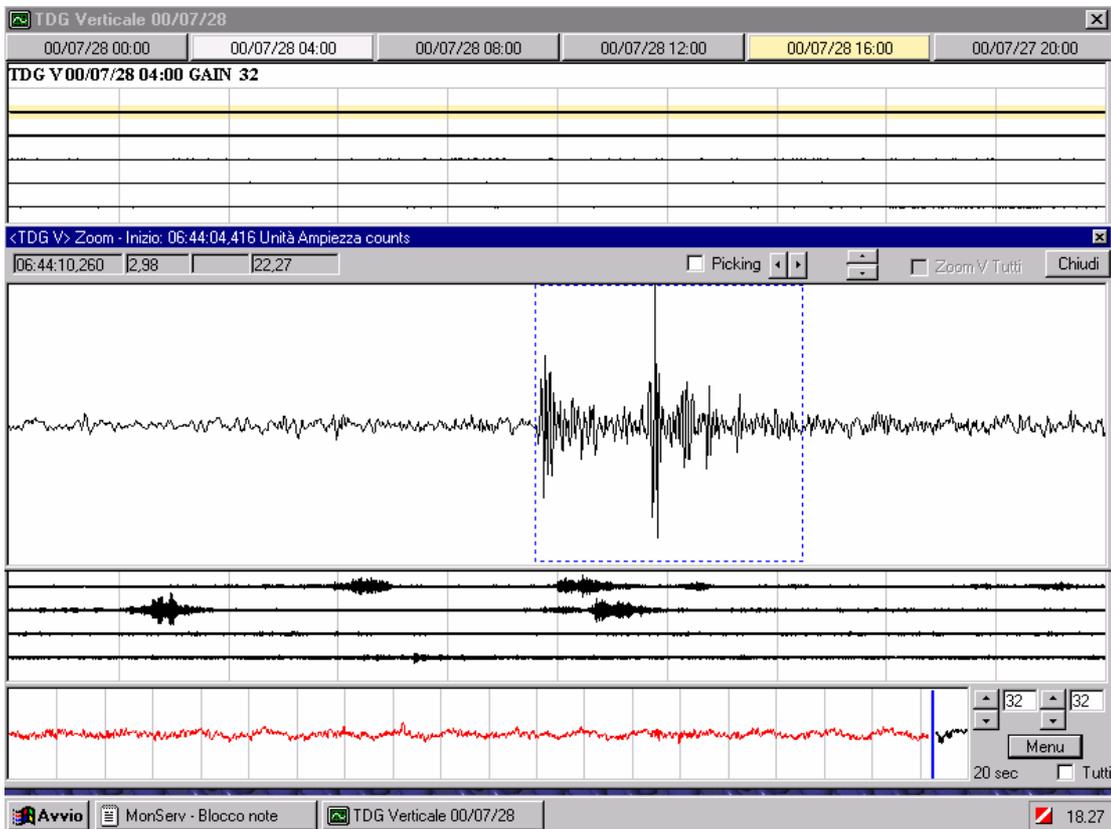Fig. 1 - Screen copy of WinDrum user interface.

Fig. 2 - The WINDRUM zoom window.

THE "MENU" FORM

WINDRUM has been designed for a poorly interactive menu, in order to avoid mistakes due to the change of the configuration parameters at the run time. Therefore the information is primarily transferred to the program at the start time by configuration file.
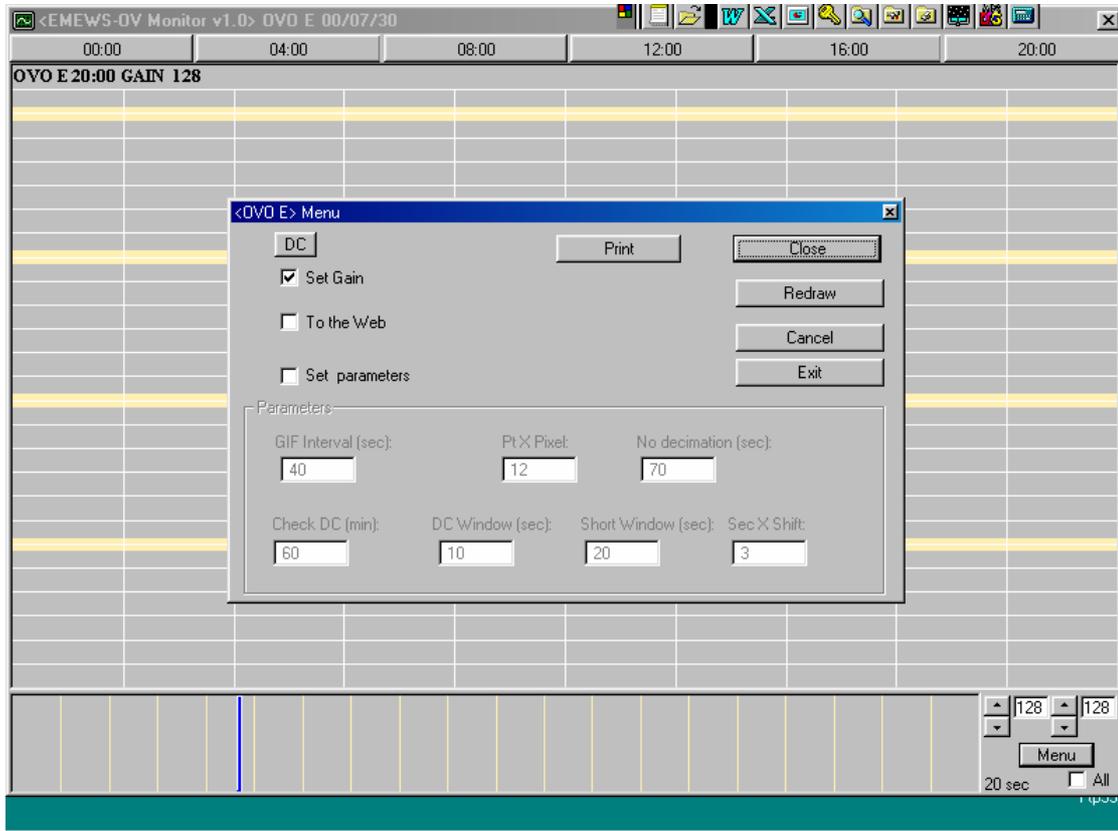

Fig. 3 - The menu form

From the "Menu Form" the user can:

- Remove the DC level by clicking the "DC" labeled command button. The DC level will be subtracted to all the incoming signal, before to plot them. This function is also activated at the start time of the program and periodically at the run time.
- Enable the gain setting.
- Enable the GIF or JPG creating procedure. Note that this entry is not present in the setup file. The only way to activate the procedure is to use this check box.
- Print on paper the currently displayed graphical page by clicking "Print" button.
- Redraw all the displayed data by clicking "Redraw" button. It can take several seconds, but is useful when the user need to plot all the signal with a new gain scale.
- Enable the frame at the bottom of the form where it is possible to change the value of the following configuration parameters:
  1. GIF interval   Time interval to produce the GIF or JPG format plot for the Web page
  2. PtXPixel   NOT USED
  3. Check DC (min)   Time interval to recalculate the DC level
  4. DC Window (sec)   Time length of the signal used to calculate the DC level
  5. Short Window (sec)   Time length of the displayed incoming signal
  6. No Decimation   Minimum value of calculated ratio N Samples/Pixel for applying a decimation when plotting the zoomed signal window.
  7. Sec X Shift   Factor shift for moving the vertical bar displayed in the incoming signal picture box.
- Close the window saving the new settings by choosing the "Close" button.
- Close the window without saving any new settings by choosing the "Cancel" button.

4

- Stop the program by clicking the "Exit" button. When clicking this button a message form will appear asking the user to confirm the exit request.

THE CURRENT CONFIGURATION AT THE OSSERVATORIO VESUVIANO

At the present time the seismic monitoring system of the Osservatorio Vesuviano is based on WINDRUM, with 7 PC and 26 monitors dedicated to the traces display. An internal hidden sub-network has been created to isolate the network traffic of the seismic monitoring system. All the channels routinely monitored (21 channels) are full screen displayed. Some of the channels temporarily monitored are displayed in an half or a quarter of the screen, such those of the new installed or recently fixed stations.

Fig. 4 – A view of the Osservatorio Vesuviano seismic monitoring system

At the Osservatorio Vesuviano a multi-monitor configuration is adopted using graphic board PCI on Win98 operating system. The standard configuration is an assembly of 4 monitors for each machine set as shown in fig. 5. Following an internal convention, the main program, which sends commands and optionally data messages to the others, corresponds to the monitor #1, whereas the program that copies images to the WEB server corresponds to the monitor #3. At the present time there are six channels on the Osservatorio Vesuviano WEB pages that automatically refresh every 60 seconds (http://www.ov.ingv.it/seismogroup-file/monitors.htm).

RUNNING WINDRUM

To install Windrum the user must execute the SetUp program, contained into the installation packet. The setup program installs all the necessary files on the user's machine. Once the installation is correctly completed the user can invoke the program execution by clicking START from the Windows system environment; then choosing PROGRAMS or choosing RUN, to execute it from the command line. When the application is run from the command line it may take a single argument which specifies the complete path and filename for an input configuration file, containing default parameters. If no argument is passed to the program it asks the user to supply an initialization filename via "Input Box". If the specified file is not present on the disk the program will stop. Once the program is started it loads the appropriate settings from the configuration file, set up as described in the following section, and looks for the current and previous files DAY. If the files are present WINDRUM redraws all their data (it can take several seconds) then it listens to TRACE_BUFFER data type messages. The user can supply the data by activating any program that sends at the IP computer address or in broadcast mode UDP packets in a format compatible with the Earthworm TYPE_TRACEBUF structure. WINDRUM selects the data on the base of the station name and channel name. At the Osservatorio Vesuviano several modules are used to send

data packets getting the data directly from the acquisition system or reading them from different format files (Giudicepietro et al., 2000). The program is also tested with ringtocax module of Earthworm.
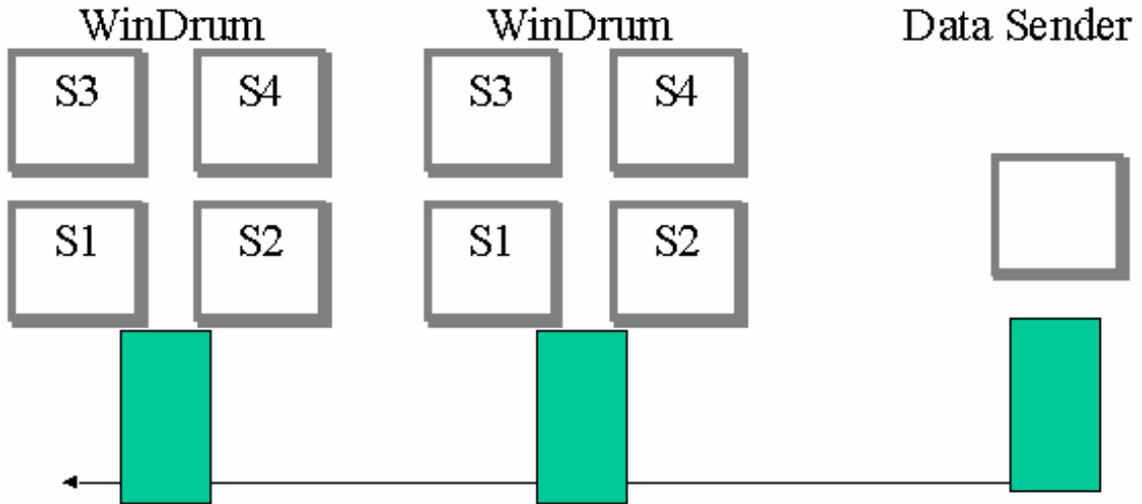

Fig. 5 – The standard setting of the multi-monitor configuration at the Osservatorio Vesuviano seismic monitoring center.
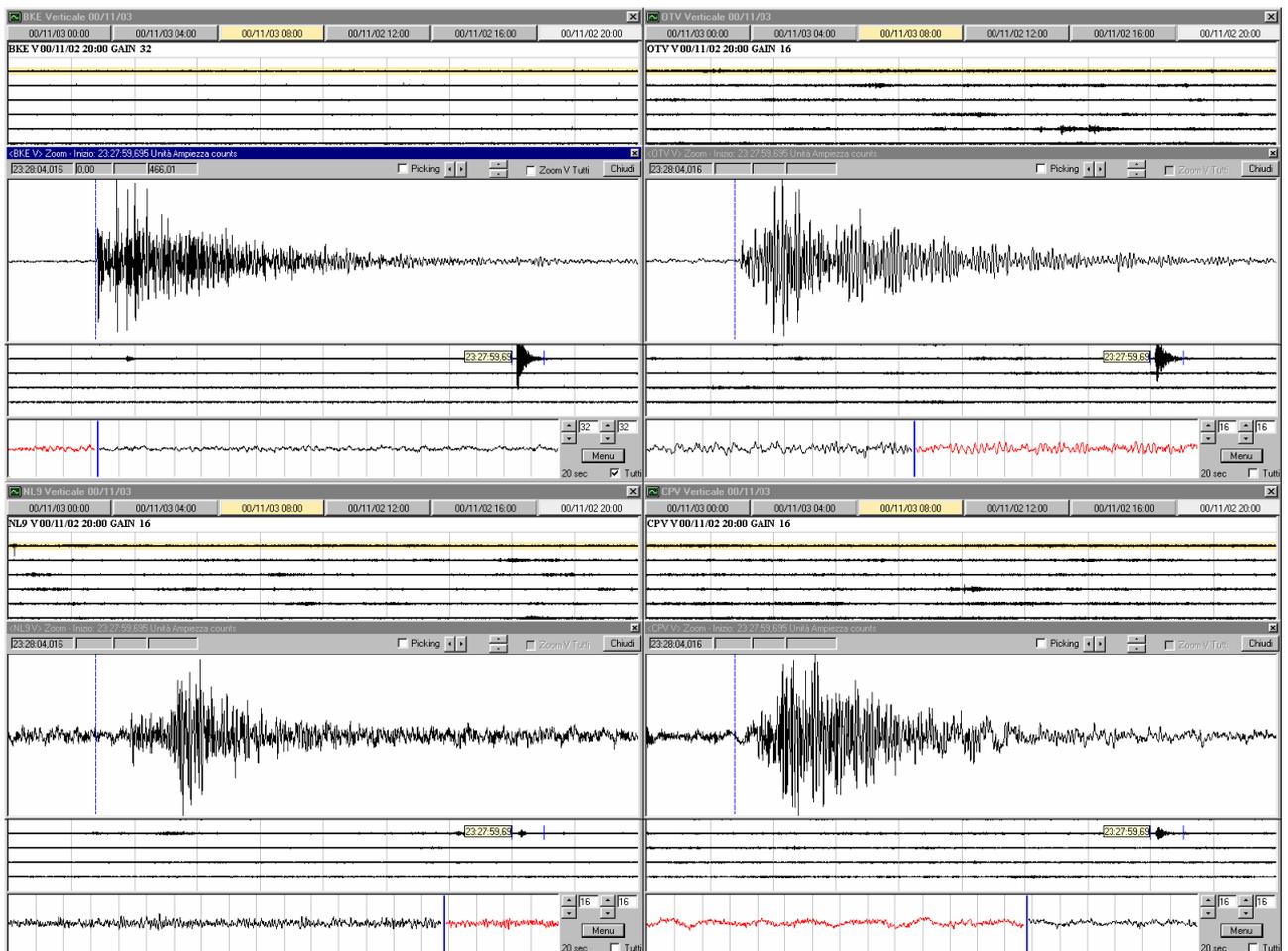

Fig. 6 – Screen copy of WinDrum programs user interface using a 4 monitors configuration.

THE CONFIGURATION FILE

The configuration file contains the following parameters:

1)	FLAG_2000	Integer
2)	MONITORS NUMBER	Integer
3)	MONITORS CONFIGURATION	Integer
4)	MONITOR ID	Integer
5)	POSITION	Integer
6)	FLAG_TASKBAR	Integer
7)	GIF OR JPG PROCEDURE	String
8)	GIF OR JPG FILENAME	String
9)	WEB SERVER PATH	String
10)	LOCAL FILES PATH	String
11)	FLAG_WRITE	Integer
12)	FLAG_DEL	Integer
13)	SAMPLING RATE	Single
14)	V-LINE	Integer
15)	AMP MAX	Single
16)	UNIT	String
17)	GAIN BASE 1	Single
18)	GAIN BASE 2	Single
19)	WEB STEP	Integer
20)	DEFAULT GAIN	Integer
21)	PASSWORD	String
22)	STATION NAME	String
23)	CHANNEL NAME	String
24)	FLAG_COLOR	Integer
25)	MIN DECIMATE	Integer
26)	SHORT SIGNAL WINDOW	Integer
27)	BAR SHIFT FACTOR	Single
28)	SEC_IN_ROW	Single
29)	ROWS NUMBER	Integer
30)	STEP DC	Integer
31)	SEC DC	Single
32)	A M_D PARAMETER	Single
33)	B M_D PARAMETER	Single
34)	C M_D PARAMETER	Single
35)	LOCAL PROGRAM_ID	Integer
36)	COMMANDS REMOTE HOST	String
37)	DATA RECEIVER PORT	Long
38)	COMMANDS RECEIVER PORT	Long
39)	COMMANDS SEND PORT	Long
40)	N DATA CLIENTS	Integer
41)	FOR EACH DATA CLIENT	
	* STATION NAME	String
	* CHANNEL NAME	String
	* PORT	Long
42)	N COMMANDS CLIENTS	
43)	FOR EACH COMMANDS CLIENT	
	* PORT	Long

Each parameter must be followed by a comma and a comment. If the comment contains an other comma it must be enclosed in double - quotes (see the *examples configuration file* section) .

1. FLAG_2000
Flag that indicates if the program is run on Windows NT or 2000. The value must be 2000 for Win 2000 and NT; any other value can be set for the other Windows system version.

2. MONITORS NUMBER
The total number of monitors connected to the PC. The permitted values are 1, 2, 4, 6 or 8. The program has been tested with maximum 4 monitors. Actually this parameter is used only in combination with the "Monitors configuration" parameter to indicate the topology of the screens. For this reason 4 is the correct value also if you have only 3 screens on you computer.

3. MONITORS CONFIGURATION

"Monitors configuration" indicates the way you have configured the monitors layout in your PC using the control panel setup (location and an ID number). The possible configurations are:
1 = all monitors on a single line with consecutive numbers increasing from left to right or from right to left.
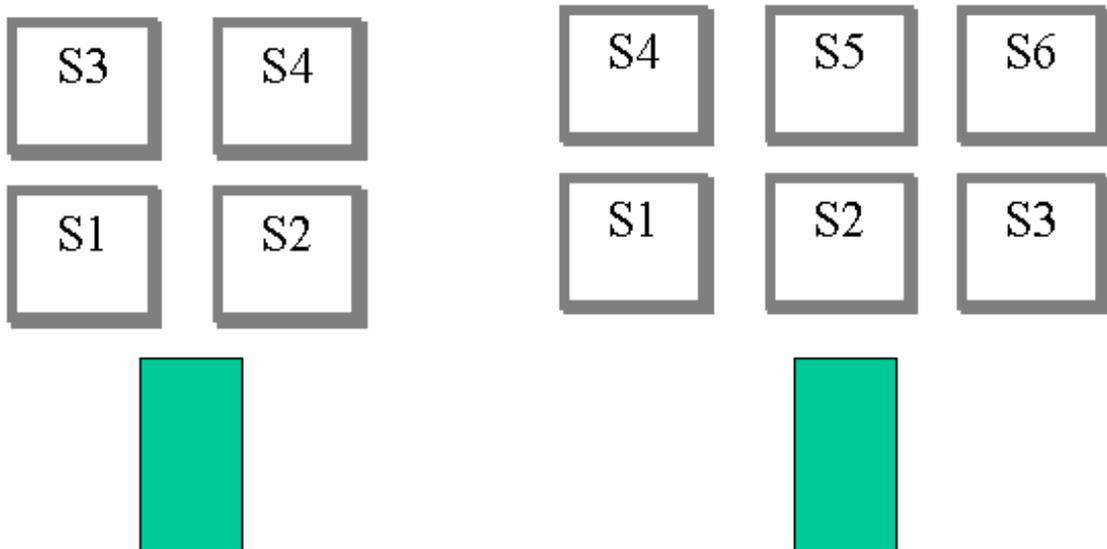2 = monitors are configured on two lines, numbered as shown in fig. 5 and fig. 7.

Fig. 7 – Two lines MONITORS CONFIGURATION example.

4. MONITOR ID
Number that specifies on which monitor the program will appear at the start time. For example, if you have one line of monitors like 4,3,2,1 to locate the program interface on the monitor 2 the MONITOR ID is -2. If you have one line of monitors like 1,2,3,4 to locate the program interface on the monitor 2 the MONITOR ID is 2. When using the two lines configuration the MONITOR ID is the same as the system monitor ID.

5. POSITION
A flag that determines the size and the screen location of the WINDRUM user interface. It is useful to display more than one program on a single monitor.
0, full screen
12, upper half screen
22, downer half screen
14, upper left quadrant of the screen
24, upper right quadrant of the screen
34, downer right quadrant of the screen
44, downer left quadrant of the screen
The program has been tested with 12 copies running on a single PC with 3 screens.

6. FLAG_TASKBAR
A flag to consider (value =1) or not (value =0) the taskbar height when designing the WINDRUM main window.

7. GIF OR JPG PROCEDURE
This parameter is an executable string that allows converting of a BMP file to a GIF or JPEG file. It will be periodically invoked by the program, the time interval depending on the "WEB STEP" parameter (see 19). That string can be a BAT filename or a command line with the converter program name and each necessary argument. The output file must be located in the LOCAL FILES PATH directory (see 10) and have the same name as the GIF or JPG filename supplied to the program by the configuration file (the next parameter). The input file must have the same path and title as the output file, but BMP extension. Once the program is started the user can activate the

periodic call of this procedure by checking the appropriate checkbox in the "Menu Form". To have 24 hours of graphical images available for the WEB the program at the changing of the page makes an extra call of this procedure and renames the output file by adding to the file title a suffice corresponding to the just completed page. When the procedure is called it will take a short time to terminate. So WINDRUM copies the file after one-second period the procedure calling to be sure that it is ended. The copying is done by creating a BAT file.

8. GIF OR JPG FILENAME
The GIF or JPG filename to copy to the WEB Server.

9. WEB SERVER PATH
The path where the program will copy the GIF or JPG files for the Web once the files creating procedure has been activated. The web server must be on the same LAN as the WINDRUM running machine, that must have write access to the appropriate directory on the WEB Server.

10. LOCAL FILES PATH
The directory where the program will create the DAY and LOG files. In this directory the program also creates the BMP and the BAT file to copy the graphical files to the WEB Server, if the GIF or JPG files creating procedure has been activated.

11. FLAG_WRITE
A flag that determines whether WINDRUM will write the DAY files.
1 = Write
0 = Not write.

12. FLAG_DEL
A flag that determines whether WINDRUM will delete the previous DAY file when change the day.
1 = Delete
0 = Not delete.

13. SAMPLING RATE
The signal sampling rate.

14. V_LINE
The interval between two contiguous vertical lines, in seconds.

15. AMP MAX
The maximum signal amplitude, depending on the A/D converter dynamics.

16. UNIT
The measures unit of the signal.
CO = counts
MV = millivolt
VL = cm/s

17. GAIN BASE 1
Base of the exponential gain for the short incoming signal window at bottom of the main form.

18. GAIN BASE 2
Base of the exponential gain for the graphical pages plot.

19. WEB STEP
Number of seconds for the WEB image update. This parameter, as all the others regarding the WEB images update, is used only if the appropriate checkbox in the "Menu Form" has been checked. It can be changed from the "Menu Form".

20. DEFAULT GAIN
Power to which "GAIN BASE 1" and "GAIN BASE 2" are to be raised to obtain the default gain factor.

21. PASSWORD
A password to stop the program or to change configuration parameters from the "Menu form". If PASSWORD ="" the program does not ask the user for any password. Obviously this in not e secret password, but it can be useful to avoid mistakes due to changing of any configuration parameter at the run time. Also if PASSWORD ="" do not omit the comma and the comment (see *configuration file examples*).

22. STATION NAME
The station name. This parameter is case sensitive. It must be exactly the same as the "Sta" field in the Trace_Header structure of the TRACE BUFFER data packets (see Appendix A).

23. CHANNEL NAME
The channel name. This parameter is case sensitive. It must be exactly the same as the "Chan" field in the Trace_Header structure of the TRACE BUFFER data packets (see Appendix A).

24. FLAG_COLOR
A flag that determines which couple of back and fore colors the user interface will be.

Value	Backcolor	Forecolor
0	gray	black
1	white	black
2	black	green

25. MIN DECIMATE
Minimum value of calculated ratio N Samples/Pixel for the decimation in the zoom window. This parameter can be changed from the "Menu Form". When WINDRUM is started it calculates the screen resolution and the number of point that it can represent within a pixel. This is the decimate factor that, in this case, is a constant value. The program uses this value to redraw the files DAY data, by applying a graphical decimation. That is performed by calculating the maximum and the minimum value in contiguous intervals of that number of samples and drawing a line from the maximum to the minimum value. When a signal window is selected for zooming WINDRUM dynamically calculates the zoom decimate factor. If this value is less than MIN DECIMATE the program will not apply any decimation.

26. SHORT SIGNAL WINDOW
The duration of the short signal window in seconds. This parameter can be changed from the "Menu Form".

27. BAR SHIFT FACTOR
A factor to appropriately move the vertical bar in the short signal window.

28. SEC_IN_ROW
The number of seconds per row.

29. ROWS NUMBER
The number of rows in a graphical page. This parameter with the previous one determine how many pages will be designed at the start time. It is possible to set those two parameters so that the number of pages results 1 (24 hours), 2 (12 hours), 3 (8 hours), 4 (6 hours), 6 (4 hours).

30. STEP DC
Time interval to recalculate the DC level, in minutes. This parameter can be changed from the "Menu Form".

31. SEC DC
Signal window time length used to calculate the DC level. This parameter can be changed from the "Menu Form".

32. A M_D PARAMETER
The "A" parameter for the duration Magnitudo M_D calculation $(M=A*Log(t)+B*d+C)$.

33. B M_D PARAMETER
The "B parameter for the duration Magnitudo M_D calculation. Generally not used.

34. C M$_D$ PARAMETER
The "C parameter for the duration Magnitudo M$_D$ calculation.

35. LOCAL PROGRAM_ID
A local program ID number, max 3 digit, unique for each program. This parameter allows a system composed by many active WINDRUM program to correctly exchange command messages by using a broadcast transmission. When one of the active WINDRUM modules receives a command message it checks the LOCAL PROGRAM_ID, contained in the message, and executes the command only if it is different from its own LOCAL PROGRAM_ID.

36. COMMANDS REMOTE HOST
The broadcast remote host to send command messages to. This parameter is the same for all the WINDRUM program of a given seismic monitoring system.

37. DATA RECEIVER PORT
The port over which the program receives the data packets. Over this port WINDRUM can receive also data for other programs running on the same machine. In this case the user must build a list of the data clients as described below (see 40-41). In any case if more then one WINDRUM are running on the same machine each of them must have different DATA RECEIVER PORT.

38. COMMANDS RECEIVER PORT
In a given seismic monitoring system based on WINDRUM when one of the active WINDRUM modules transmits a command to the others it broadcasts the message to a single specified port (see 39). For each machine composing the monitoring system only the main WINDRUM program will be able to get the command messages on that port and it will resend them to the others. So the main program must have the same COMMANDS RECEIVER PORT number as the COMMANDS SEND PORT. The programs running on a PC must have COMMANDS RECEIVER PORT different from each others.

39. COMMANDS SEND PORT
In a given seismic monitoring system based on WINDRUM when one of the active WINDRUM modules transmits a command to the others it broadcasts the message to a single specified port. So all the WINDRUM programs of the monitoring system must have the same COMMANDS SEND PORT.

40. N DATA CLIENTS
Number of data clients. If N DATA CLIENTS is equal to 0 then the program will directly reads the parameter 42.

41. FOR EACH DATA CLIENTS
If N DATA CLIENTS is greater than 0 then the program reads for each data client:
      the STATION NAME;
      the CHANNEL NAME;
      the DATA RECEIVER PORT.

42. N COMMANDS CLIENTS
Number of commands clients. If N COMMANDS CLIENTS is equal to 0 then the program stops reading the configuration file.

43. FOR EACH DATA CLIENTS
If N COMMANDS CLIENTS is greater than 0 then the program reads for each data client the DATA RECEIVER PORT. Unlike the case of the data clients if more then one WINDRUM are running on the same machine it is necessary to configure one of the program as main to resend command to the others.

CONFIGURATION FILE EXAMPLES

The standard configuration used at the Osservatorio Vesuviano seismic monitoring system for a main WINDRUM program (STA00):

98,	FLAG_2000
4,	MONITORS NUMBER
2,	MONITORS CONFIGURATION
1,	ID MONITOR
0,	POSITION
0,	FLAG_TASKBAR
GIF or JPG creating procedure,	GIF OR JPG PROCEDURE
STA00.GIF,	GIF OR JPG FILENAME
X:\WWWPATH\,	WEB SERVER PATH
C:\SIGNALS\STA00\,	LOCAL FILES PATH
1,	FLAG_WRITE
0,	FLAG_DEL
100.00,	SAMPLING RATE
60,	V-LINE
32760,	AMP MAX
Co,	UNIT
2,	GAIN BASE 1
2,	GAIN BASE 2
40,	WEB STEP
5,	DEFAULT GAIN
,	PASSWORD
STA00,	STATION NAME
V,	CHANNEL NAME
1,	FLAG_COLOR
16,	MIN DECIMATE
20,	SHORT SIGNAL WINDOW
3,	BAR SHIFT FACTOR
600,	SEC_IN_ROW
24,	ROWS NUMBER
60,	STEP DC
10,	SEC DC
3.3,	A M_D PARAMETER
0,	B M_D PARAMETER
-3,54,	C M_D PARAMETER
1,	LOCAL PROGRAM_ID
Broadcast address,	COMMANDS REMOTE HOST
1980,	DATA RECEIVER PORT
2980,	COMMANDS RECEIVER PORT
2980,	COMMANDS SEND PORT
3,	N DATA CLIENTS
STA01,	STATION NAME CLIENT 1
V,	CHANNEL NAME CLIENT 1
1981,	DATA PORT CLIENT 1
STA02,	STATION NAME CLIEN2
V,	CHANNEL NAME CLIEN 2
1982,	DATA PORT CLIENT 2
STA03,	STATION NAME CLIENT 3
V,	CHANNEL NAME CLIENT 3
1983,	DATA PORT CLIENT 3
3,	N COMMANDS CLIENTS
2981,	COMMANDS PORT CLIENT 1
2982,	COMMANDS PORT CLIENT 2
2983,	COMMANDS PORT CLIENT 3

The standard configuration used at the Osservatorio Vesuviano seismic monitoring system for a "client" WINDRUM program (STA01):

98,	FLAG_2000
4,	MONITORS NUMBER
2,	MONITORS CONFIGURATION
2,	ID MONITOR
0,	POSITION
0,	FLAG_TASKBAR
GIF or JPG creating procedure,	GIF OR JPG PROCEDURE
STA01.GIF,	GIF OR JPG FILENAME
X:\WWWPATH\,	WEB SERVER PATH
C:\SIGNALS\STA01\,	LOCAL FILES PATH
1,	FLAG_WRITE
0,	FLAG_DEL
100.00,	SAMPLING RATE
60,	V-LINE
32760,	AMP MAX
Co,	UNIT
2,	GAIN BASE 1
2,	GAIN BASE 2
40,	WEB STEP
5,	DEFAULT GAIN
,	PASSWORD
STA01,	STATION NAME
V,	CHANNEL NAME
1,	FLAG_COLOR
16,	MIN DECIMATE
20,	SHORT SIGNAL WINDOW
3,	BAR SHIFT FACTOR
600,	SEC_IN_ROW
24,	ROWS NUMBER
60,	STEP DC
10,	SEC DC
3.3,	A M_D PARAMETER
0,	B M_D PARAMETER
-3,54,	C M_D PARAMETER
2,	LOCAL PROGRAM_ID
Broadcast address,	COMMANDS REMOTE HOST
1981,	DATA RECEIVER PORT
2981,	COMMANDS RECEIVER PORT
2980,	COMMANDS SEND PORT
0,	N DATA CLIENTS
0,	N COMMANDS CLIENTS

REFERENCES

Johnson, C.E., Bittenbinder A., Bogaert B., Dietz L., Kohler W.; Earthworm: A Flexible Approach to Seismic Network Processing, *IRIS Newsletter*, V14 N2, p1-4, 1995.

F. Giudicepietro, W. De Cesare, M. Martini, V. Meglio; Il sistema sismometrico modulare integrato (SISMI). Atti del 19° Convegno Nazionale GNGTS (CNR) Roma 7-9 novembre 2000.

APPENDIX A

- **Packet_Header :** *The definition of an Earthworm UDP packet*

Field	Description	Type
MsgInst	Message Installation (0=>Earthworm)	unsigned char
MsgType	Message Type (20=> Trace_Buffer)	unsigned char
ModId	Id of module originating message	unsigned char
FragNum	Packet number of message; 0=>first	unsigned char
MsgSeqNum	Message Sequence number	unsigned char
LastOfMsg	1=> last packet of message, else 0	unsigned char

- **Trace_Header :** *data buffer header*

Field	Description	Type
Pinno	Pin number	Int
Nsamp	Number of samples in packet	Int
Starttime	Time of first sample in epoch seconds (seconds since midnight 1/1/1970)	Double
Enditime	Time of last sample in epoch seconds	Double
Samprate	Sample rate; nominal	Double
Sta	Site name	Char [7]
Net	Network name	Char [9]
Chan	Component / channel code	Char [9]
Datatype	Data format code	Char [3]
Quality	Data-quality field	Char [2]
Pad	Padding	Char [2]

- **Trace_Buffer** : *data packet*

Packet type	description
Packet_Header	Packets identifier
Trace_Header	Header of data buffer
Samples Array	Data buffer