ISTITUTO NAZIONALE DI OCEANOGRAFIA E DI GEOFISICA SPERIMENTALE

Centro di Ricerche Sismologiche

SeedLink server for Kinemetrics Etna and K2 digitizers based on SBC Raspberry Pi

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Kinemetrics Etna digitizer

Altus digitizers (Etna and K2) from Kinemetrics are low power strong motion accelerographs with integrated 3 channel EpiSensor FBA accelerometer (K2 is provided with 3 additional channels to work with external seismometer).

Etna digitizer can detect events through acceleration trigger thresholds and store it on internal PCMCIA memory card, while K2 can detect events using more efficient STA/LTA trigger algorithm.

Both instruments can be also configured to work in real-time mode sending seismic data through serial interface.

MAIN FEATURES (Etna):

DATA ACQUISITION

- **3 channels**
- **High dynamic range** (108dB @200sps)
- **Frequency response DC to 80Hz** (@200sps)
- **18 bit resolution** (@200sps)
- **User selectable sampling rate** (100, 200, 250)

SENSOR

- **Triaxial EpiSensor FBA**
- **User selectable full-scale range** (0,25 to 4g)
- **DC to 200Hz bandwidth**
- **155dB dynamic range**

COMMUNICATIONS

- **RS-232 interface** (setup, data exchange)

DISPLAY

- **3 leds** (run/fault, charge, event)

STORAGE

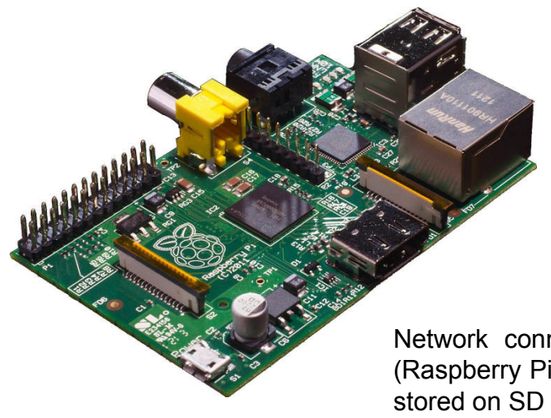
- **Up to 2 PCMCIA storage cards**
- **Recording capacity ~8min/MB** (3ch @200sps)

POWER SUPPLY

- **External 220Vac PSU**
- **Internal 12V battery** (6.5Ah standard, 12Ah option)
- **Current drain ~185mA @12V**
- **Autonomy >36hrs** (standard battery)

SOFTWARE

- **QuickTalk/QuickLook** (Kinemetrics)
- **Antelope**
- **Earthworm**



Raspberry Pi

Raspberry Pi is a low cost, low power SBC (Single Board Computer) running Linux OS. This small credit-card sized computer can easily be connected to standard USB devices (keyboard, mouse and so on) and plugged to a monitor provided of HDMI or RCA inputs.

Network connectivity is provided from embedded ethernet interface (Raspberry Pi model B only) while Debian OS and user data space are stored on SD card.

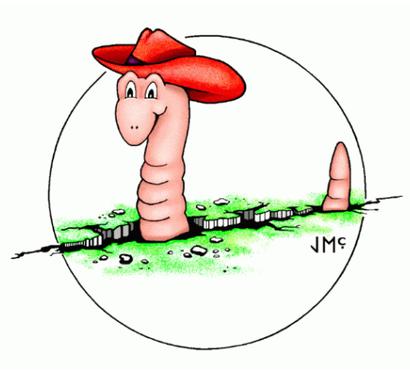
MAIN FEATURES:

- **Low cost** (~35€)
- **Low power** (~700mA @ 5Vdc)
- **Small form factor** (85,6mm x 53,98mm)
- **USB interface** (n° 1 model A, n° 2 model B)
- **Video output HDMI or videocomposite**
- **Ethernet** (only model B)
- **Audio output** (3,5mm jack)
- **Debian OS pre-installed**
- **OS and storage memory on SD card**
- **System on Chip**
  - Broadcom BCM2835
  - CPU ARM 700MHz
  - GPU Broadcom VideoCore
  - SDRAM 256/512MB
- **Peripherals**
  - GPIO, I2C bus, SPI bus, UART

EarthWorm

EarthWorm is an open source free software mainly used for network seismology from many organizations in the world to monitor earthquakes and volcanoes.

Developed by ISTI (Instrumental Software Technologies, Inc.) from early 1990s, EarthWorm could be now easily installed on Windows and Linux operating systems and it's provided with several plugins for most common seismic digitizers used in seismic networks.



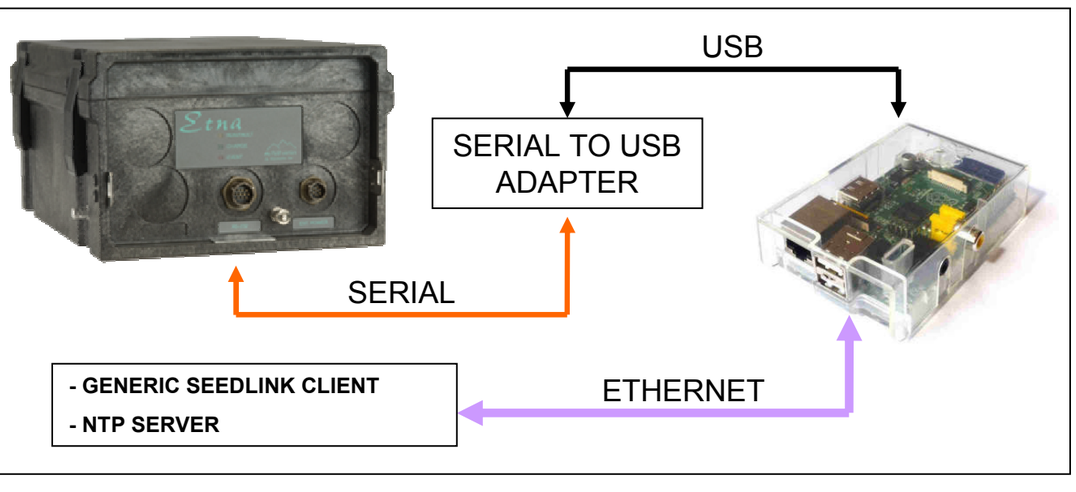
SeedLink server interface for Etna and K2 digitizers

Nowdays Etna digitizer, even if good low-power, low-cost compact accelerometer still used in several seismic networks, is an obsolete device if compared to latest instruments: due to first 1990s technology, PCMCIA storage support and serial interface are not so user-friendly such USB storage devices and network interfaces.

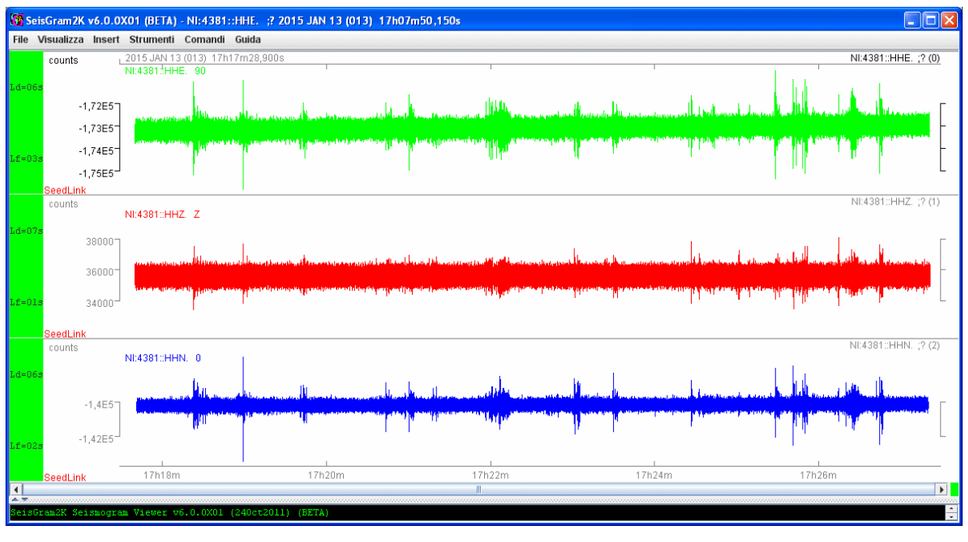
Over these hardware issues Etna and K2 works with proprietary Kinemetric protocol, so not all seismic softwares can manage it, meanwhile quite all modern instruments are able to exchange data with standard protocols such SeedLink.

A nice solution would be to use Etna (or K2) with local acquisition system to collect data from serial port, then make data available trough a server according to standard SeedLink protocol for other acquisition systems.

EarthWorm software is provided with specific plugins for K2 digitizer (working also on Etna) and can be set to collect real-time data from serial port; at the same time EarthWorm is a free and open-source solution that can run on low-cost, low-power Linux embedded devices such Raspberry Pi; additional plugins of EarthWorm could also make data available through a server for SeedLink protocol.



SeedLink server system diagram



SeedLink server test using SeisGram2K

REFERENCES

- Kinemetrics – http://www.kinemetrics.com
- EarthWorm User Community – http://love.isti.com/trac/ew
- EarthWorm Community Forum Google Groups
- Raspberry Foundation – www.raspberry.org
- IRIS Supported Software – ringserver – http://seiscode.iris.washington.edu/projects/ringserver