Mole: an open near real-time database-centric Earthworm subsystem

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Introduction

Earthworm (Johnson et al. 1995) is an automatic processing system for earthquake localization. The initial objective of the project was to provide rapid notification of seismic events and not necessarily was to have a persistent memory of the past events. Subsequently, a public interactive subsystem, made up of several modules for loading/retrieving information in/from an Oracle® database, was provided. However, the last public version of the Interactive Earthworm dates back to May 2003, after which, it has been discontinued.

After several years of successful tests using Earthworm for seismic event detection in Italy (Mazza et al. 2008), INGV National Earthquake Center decided to substitute the pre-existent localization program with the Earthworm system, interfacing it with the current event revision procedures. The main issue to face was that the common output parameters produced by Earthworm, like phase picks, event locations, magnitude, data triggers and error messages were reported only by e-mail or recorded on local disk files: one had to deal with scattered files in diverse formats, whenever analyzing or debugging Earthworm. Therefore, we decided to design a homogeneous high-level Earthworm communication layer for storing data and interfacing it with the pre-existent external procedures.

The experience provided by the Winston software (Cervelli et al. 2004; Cervelli 2005) had already demonstrated that MySQL® DBMS could sustain the heavy load of storing in near real-time the earthquake sequences.

We have designed and developed Mole, an open-source and cross-platform Earthworm subsystem (Friberg et al. 2010) rely on MySQL®.

Mole Components

Mole consists of:

- **MOLEDB**: a MySQL database which hosts Earthworm messages information
- **ew2moledb**: an Earthworm module which feeds MOLEDB in near real-time with information read from the Earthworm rings
- **MOLEFACE**: a web interface for browsing the information stored in MOLEDB based on Xataface (Hannah 2009).

![Mole Database Diagram](image)

Figure 1. Mole can deal with multiple Earthworm instances in near real-time and doing so permits higher continuity of the service. An Earthworm instance is an abstraction of an Earthworm running system – not to be mistaken for the Earthworm Installation that is usually identified by the code with prefix INST_.

![Mole Database Diagram](image)

Figure 2. A very generic and minimal Earthworm diagram offers a view about how the single parts of the system can be connected to each other. Generic Earthworm modules are attached to one, or more rings, and then get and put messages from and into the attached rings. ew2moledb can be configured to read a custom subset of message types from a ring, and then translate the message information and load it into the database MOLEDB.

![Mole Database Diagram](image)

Figure 3. The boxes representing tables and the arrows foreign key relationships. Mole can handle most of the common earthworm message types and is able to map Earthworm instances, SCNL codes and pick/quake sequence numbers generated by the modules running on different Earthworm instances. The database schema is closely related to the types of earthworm messages to simplify to add new message types and to implement fast loading operations into the database. The INSERT operations are executed within the stored procedures called by the Earthworm module ew2moledb.

![Mole Database Diagram](image)

Figure 4. MOLEFACE can show a summary list of recent earthquake locations produced by the different Earthworm instances and displays the details of a selected earthquake location.

Main Features

- **Free system based on open-source and cross-platform software.**
- **Capable of storing in near real-time information contained potentially in every type of Earthworm message, present or future.**
- **Robust enough to sustain the heavy load generated during earthquake sequences.**
- **In case of temporary database connection failures, the system buffers the loading operations and postpone their executions until the connection is reestablished.**
- **Capable of loading data from multiple Earthworm at the same time.**

Conclusion

We have designed and developed Mole, an open-source and cross-platform Earthworm subsystem made up of a MySQL database, an Earthworm module and a web interface. Although it sprang from INGV requirements, Mole is as general-purpose as possible in order to provide an high-level communication layer to Earthworm. The opportunity of database interfacing can boost the community contributions towards a new “Open Interactive Earthworm”, for near real-time monitoring of Earthworm operation and manual revision of earthquake locations. It could also be used to disseminate the results, generate reports and statistics or post-process the bulk of off-line data.

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References