WARNING: All EGI system components must be installed and configured by an EGI support or authorized engineer. Deviating from the supported configuration or running the system with non-EGI-approved components attached can cause hazards or unexpected performance.

Amp Server Pro SDK is a powerful tool for proficient application programmers.

It is a software development kit (SDK) that allows you to talk with Amp Server™. With it you can use your own applications to connect to Amp Server, operate EGI's Net Amps™ amplifiers (NA 300 and NA 400 series) within EGI's Geodesic EEG Systems™ (GES 300 and GES 400 series), monitor a Net Station™ acquisition session in real time, and record dense array EEG data across your network. Amp Server Pro SDK provides you with the choice of using its:

- ready-to-use client libraries, which are usable with a variety of languages and platforms (see the *Amp Server Pro SDK High-level API* reference manual [8409501])
- network protocols, which is language independent (see the *Amp Server Pro SDK Network Protocols* reference manual [8409502])

You can also use Amp Server Pro SDK to interface with BCI2000, which is a free general purpose system for brain-computer interface (BCI) research. BCI2000 can also be used for data acquisition, stimulus presentation, and brain monitoring applications. For details, visit www.bci2000.org.

CAUTION: Anyone who is not completely proficient with all aspects of customizing their EEG system should not attempt it. Poorly programmed applications could cause processes to fail or corrupt EEG data.

Amp Server and Amp Server Pro SDK

Amp Server and Amp Server Pro SDK work together as shown below and in Figure 1:

Amp Server

The core software that controls, collects, and publishes data from EGI's Net Amps amplifiers over the network to clients.

Features

- Collects EEG data in real time.
- Accesses the Net Amps amplifier's hardware features, including calibration measurements.
- Adjusts your paradigm based on a patient/subject's EEG using your real-time data analysis tools.
- Connects to multiple clients simultaneously.

Amp Server Pro SDK

A software development kit that allows you to talk with Amp Server, and thus EGI's Net Amps amplifiers, using your custom applications.

Features

- Includes Amp Server with the complete Amp Server Pro SDK package, including Server-side API, High-level API, and network and data protocols.
- Provides example projects, which you can use as is with the given defaults or customize as little or as much as desired.
- Provides protocol documentation that describes a simple interface for communicating with Amp Server using Unix Makefiles, Xcode (Mac OS X), or MATLAB platforms.

Note: Amp Server and Amp Server Pro SDK perform as intended only if you use compatible versions. Therefore, you must always upgrade both.
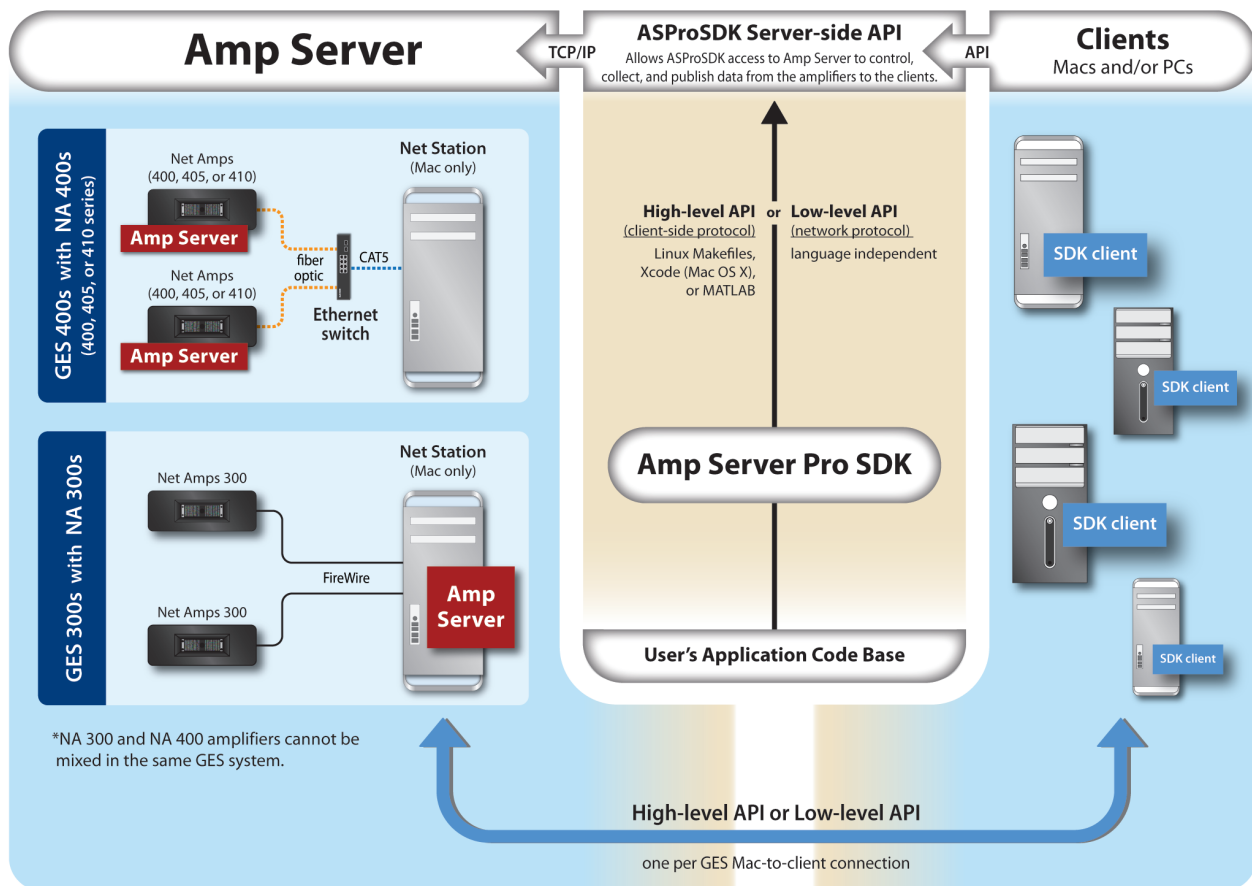

Figure 1. Amp Server and Amp Server Pro SDK architecture

The following components are included in Amp Server Pro SDK:

- **Amp Server**. The core software that provides control of EGI's Net Amps amplifiers.

- **Amp Server Pro SDK Server-side API**. Though accessible, this component is not needed for accessing amplifier data. Its main purpose is to provide customers with a replication service. One example of its use is presented in the ECI Server example project. For details, please contact EGI Technical Support.

- **Amp Server Pro SDK High-level API** (client-side protocol). The component of Amp Server Pro SDK that provides convenient libraries and utilities with which to easily communicate with the server-side of Amp Server Pro SDK (and ultimately Amp Server). The high-level API is a *client-side protocol* that provides essential solutions for common functionalities. Its libraries contain bits of code that can be inserted into an existing application that is using one of the supported programming languages (see "Amp Server Pro SDK Features"). It does not, however, allow for as much control over customization as do the network protocols. Despite that, it does meet the needs of most users and shields users from

API changes, which reduces the time needed to program and maintain a user's application code base. This, in turn, allows users to focus on their EEG data, not programming tasks.

Note: The high-level (client-side protocol) API includes library support for Linux and Mac OS. These libraries have been tested under Mac OS 10.10, Ubuntu 15.04, and Ubuntu 15.10.

- *Amp Server Pro SDK Network Protocols*. The component of Amp Server Pro SDK that defines all the network protocols and data formats used in the Amp Server Pro SDK. Using the protocols, it is possible to implement client applications in any desired programming language.

- *Amp Server Pro SDK documentation*. Complete documentation of (and requirements for) the high-level (client-side protocol) and network protocol features that communicate with Amp Server.

- *Example code*. Source code that is tested for a range of platforms and scenarios that can be used as is or customized as much as needed. Example code also includes compiled versions of the code.

Architecture Overview

Amp Server and the Net Amps amplifiers form an integrated system within a GES system. GES systems are complete electroencephalography (EEG) systems that allow you to acquire, review, and analyze up to 256 channels of EEG with Net Station.

Amp Server both sends commands to and collects data from its associated amplifier(s) and delivers that data to the connected system computers (GES or client). See Figure 1.

Be aware that there are significant differences between the NA 300 and NA 400 series amplifiers:

- Amp Server resides on different system components for GES 300 and GES 400 systems:

  - **GES 400 systems**: Amp Server runs within the NA 400 amplifiers in an embedded Linux OS environment.

  - **GES 300 systems**: Amp Server runs within the system's Mac computer and interacts with the system's amplifiers via FireWire.

- **NA 400s** have an embedded Linux OS and associated software, whereas NA 300s have very basic control software.

- **NA 400s** have a two-stage process for shutting down:

  The amplifier's internal software MUST be stopped before the amplifier's hardware can be powered down. Refer to the GES 400 series manual (8100400).

- NEVER unplug an **NA 300** amplifier's FireWire cable when it is powered: The hardware of NA 300s is constantly powered via its power connections. Refer to the GES 300 series manual (8103003-50).

- ALL **NA 300s** must be plugged into the system computer that is running Amp Server.

- System computers are shipped with automatic updates turned off to retain compatibility between the computer's OS and the Net Station software. Always contact EGI Technical Support before updating/upgrading your system computer.

For details about Amp Server, refer to the Amp Server guide (8409503).

Programming Methodologies

Amp Server interacts with the system's amplifiers according to the connections shown in Figure 1. Each amplifier responds to a set of commands from Amp Server. Amp Server Pro SDK enables the user's application code to send commands to Amp Server, which in turn sends the commands to the amplifiers. When properly programmed, Amp Server Pro SDK enables your application to have as much control over the state and run modes of the amplifiers as does Amp Server.

When communicating with Amp Server via Amp Server Pro SDK (and your application code), you can use either Amp Server Pro SDK's High-level API (client-side protocol) or Amp Server Pro SDK's network protocols. The high-level API provides you with a convenient set of libraries and example code for use within client applications, whereas the network protocols allow client applications to bypass the convenience libraries and talk directly to Amp Server over the network. See "Amp Server and Amp Server Pro SDK" for the pros and cons of each.

A higher level of expertise is required for using the network protocols. If you choose this method, contact EGI Technical Support at supportteam@egi.com before proceeding. Since most users will use the high-level API libraries and utilities, the remainder of this introduction will focus on the high-level API.

When using the high-level API, the gateway to Amp Server is via the **AS_Network_Client** class. This class mediates notifications, commands, and data.

The AS_Network_Client Class

Commands

Commands sent from the user's application code base can be sent directly to Amp Server or directly to a particular amplifier. Some commands will result in return information and some not. Regardless, Amp Server handles all commands synchronously. As such, **AS_Network_Client** objects are thread safe for sending commands. For other methods in this API, they are listed as thread safe or not; but most are thread safe.

Notifications

Notifications are events that indicate some change in the Amp Server Pro SDK environment. These events (e.g., dropped connections, amplifier installed, and amplifier removed) can come from the Amp Server or the Amp Server Pro SDK. They are received from Amp Server asynchronously. It is recommended that an application listen to these events, although it is not necessary. However, because of the asynchronous nature of Amp Server's notifications, applications are required to use a threaded design. The Observable/Observer pattern is used for the notification system.

Data

Data are streamed to clients from the moment that each client connects (assuming that the desired amplifier is running).

Example Codes

Simple Client. This is our Linux entry-level example. It provides a very detailed example of how to collect data from the Amp Server (with either the Net Amps 400 or 300 amplifiers) using the high-level API. To begin understanding this example, look at the ReadMe file and then the Simple Client application.

Amp Server Pro SDK Write to MFF. This example builds on what you learned from the Simple Client application. This is a fully featured UI example, written using the UI environment of Apple's Cocoa API. This example shows how to send commands, collect data, and save data to an MFF file.

ECI. This is a very simple example of the ECI client/server interaction.

> **Client** – Demonstrates the client.

> **Server** – Demonstrates the server.

AmpLab. This is our MATLAB example. It demonstrates the usage of a MEX interface to C/C++ to collect data in the MATLAB environment. Please read the ReadMe file carefully.

Low-level API. This is a Linux simple example of the raw network protocol. No attempt has been made to make this capable of production quality. However, it does provide a good example of the lower level API usage.

bin. All of these examples we distributed in a *compiled* format, and they can be run directly on our supported platforms.

End-User Software License

The Amp Server Pro SDK is licensed to the end user for their own internal research use under the terms of the EGI Amp Server Pro SDK license. No use of the Amp Server Pro SDK to produce a product or service that will be resold, licensed, transferred, or shared is permitted by the end-user license. No clinical use of this product is permitted under this license. Users wishing to make commercial use of this product are invited to contact EGI regarding participation in its fee-based developers program. Contact abunnenberg@egi.com regarding participation in the developers program.

Amp Server Pro SDK
End-User Software License   Read the full license before downloading the software.

For questions or additional assistance, please contact us at:

Electrical Geodesics, Inc. (EGI)
500 E 4th Avenue, Suite 200
Eugene, OR 97401 USA

+1.541.687.7962 ● supportteam@egi.com ● www.egi.com

EGI
dense array EEG