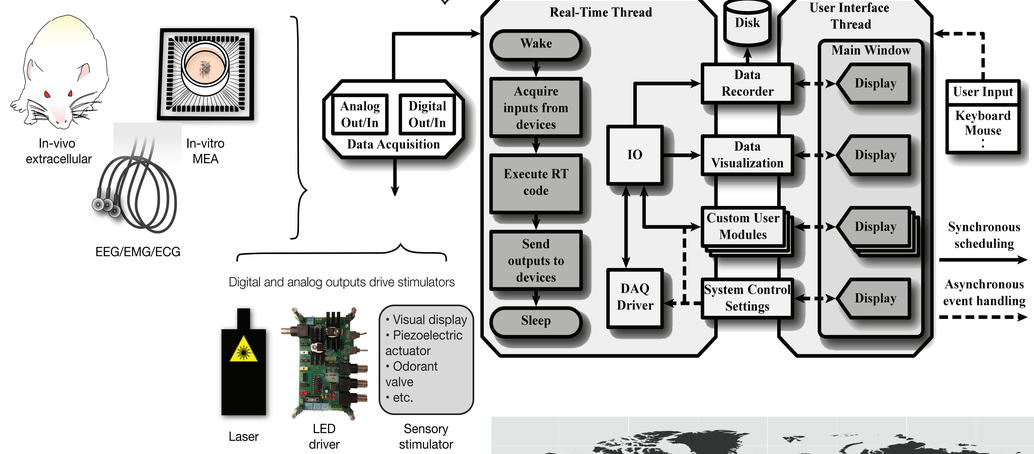
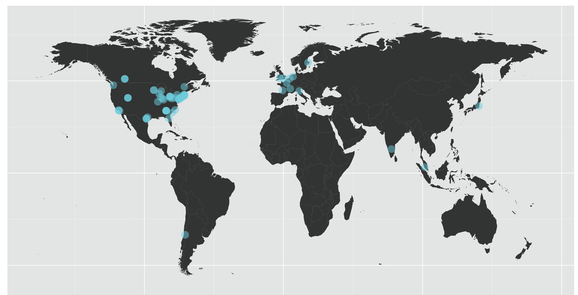
The Real-Time eXperiment Interface: a closed-loop, open-source data acquisition platform with sub-millisecond latencies for electrophysiology

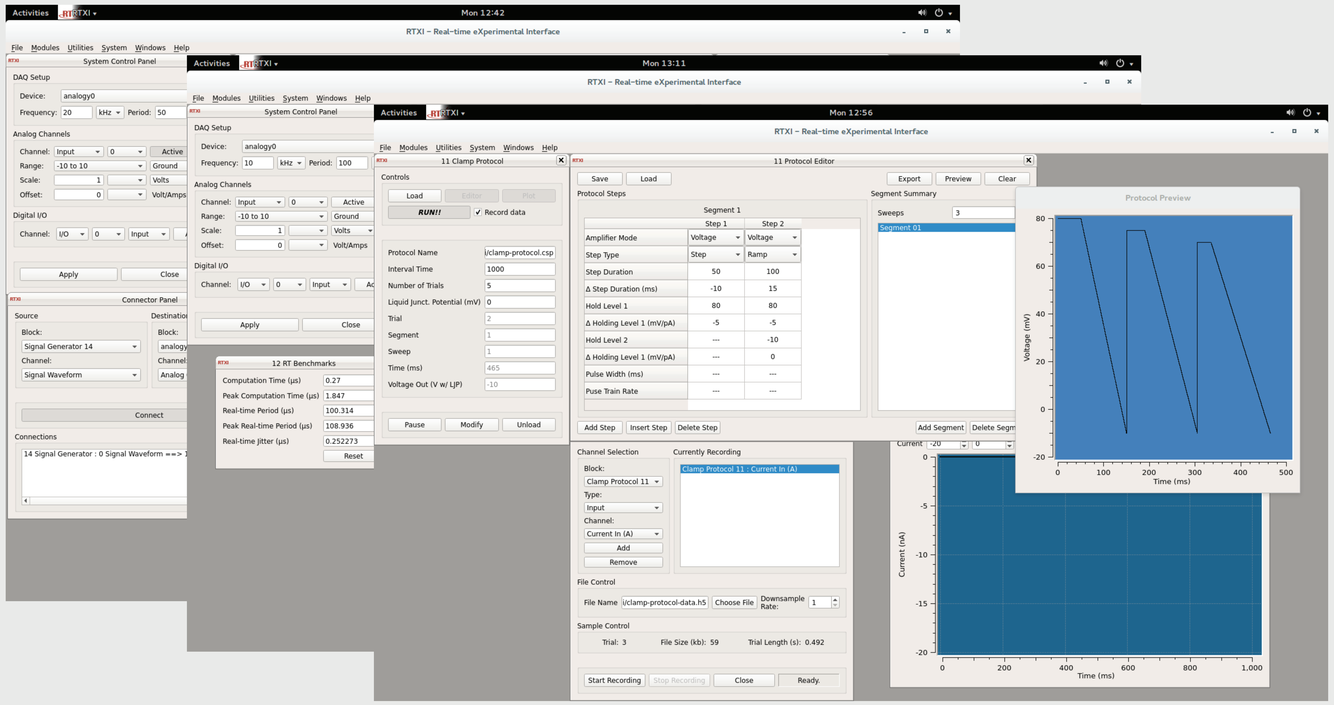
Real-Time eXperiment Interface

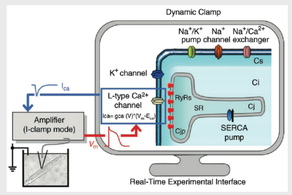
The Real-Time eXperiment Interface, or RTXI, is a closed-loop, hard real-time data acquisition and control system for electrophysiology. It is at the intersection of many open-source initiatives that provides a mature and extensible framework for designing and carrying out experiments. RTXI is free and runs on almost any modern desktop. All that's needed is a compatible data acquisition card. It can be used to simultaneously handle multichannel data acquisition through a growing set of hardware, computational models of moderate complexity, and recording to disk - all at microsecond latencies. To date, it has been used by over 60 labs around the world.





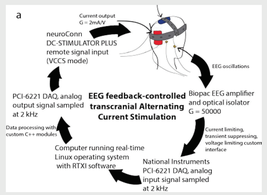
Platform overview



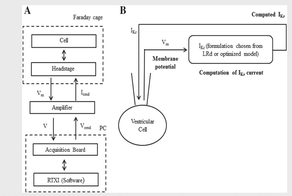


Madhvani, Roshni V., et al. "Shaping a new Ca2+ conductance to suppress early afterdepolarizations in cardiac myocytes." The Journal of physiology 589.24 (2011): 6081-6092.

Skocik, Mike, and Alexay Kozhevnikov. "Real-time system for studies of the effects of acoustic feedback on animal vocalizations." Frontiers in neural circuits 6 (2012).



Boyle, Michael R., and Flavio Frohlich. "EEG feedback-controlled transcranial alternating current stimulation." Neural Engineering (NER), 2013 6th International IEEE/EMBS Conference on. IEEE, 2013.



Chiara Bartoluccia et al. "Combined action potential- and dynamic-clamp for accurate computational modelling of the cardiac IKr current." Journal of Molecular and Cellular Cardiology.Vol. 79, February 2015, Pages 187–194.

Key features

Modular framework

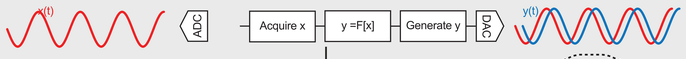
+ features implemented as standalone modules
+ dynamic loading/unloading of modules into signal chain
+ written in C++ and uses Qt
+ user-specific modules easy to create and implement

Free and open-source

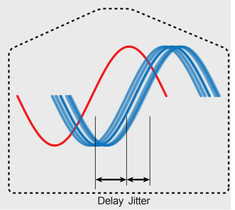
+ All code open-source and on GitHub
+ Linux: free and compatible with any modern desktop
+ Xenomai: modification to Linux that runs in real-time
+ Analogy: community driven driverset for a variety of DAQs

Hard real-time, closed-loop performance

Real-time kernel
+ Real-time threads make loop times deterministic
+ RTXI: RTLinux based biosignal acquisition software



Operation (FLOPs/Cyc.)	Latency (µsec)	Jitter (µsec)
0	~1	~.2
1000	~3	~.5
10000	~6	~2
100000	~10	~5



Resources and development

Information available online:
+ 32 and 64-bit Live CDs and installation instructions
+ source code
+ publications with relevant RTXI modules
+ bug reports, feature requests, contact information

Other resources available:
+ full-time technical support via email/-phone
+ on-site installation and troubleshooting support

Learn more
www.rtxi.org
Fork us on GitHub
github.com/rtxi

Acknowledgements

NIH RTXI is funded by NIH grant 2R01EB016407-09A1

Georgia Tech Neural Engineering
GNU/Linux
Cornell University Weill Cornell Medical College
The University of Utah
Georgia Tech
Xenomai
pggleboard

Abbreviations. ADC Analog to Digital Converter, **DAC** Digital to Analog Converter, **I/O** Input/Output, **EEG** Electroencephalography, **EMG** Electromyography, **ECG** Electrocardiography, **MEA** Microelectrode Array, **RTLinux** Real-Time Linux.