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

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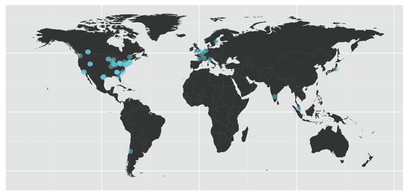
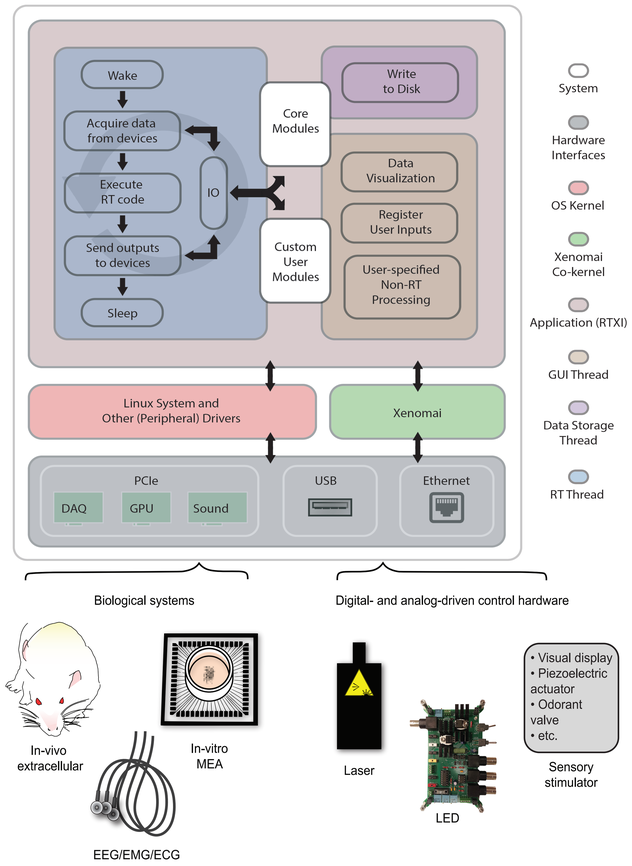
The Real-Time eXperiment Interface, or RTXI, is a closed-loop, hard real-time data acquisition and control system for electrophysiology. It is at the intersection of many open-source initiatives that provides a mature and extensible framework for designing and carrying out experiments.

RTXI is free and open source software that can be installed on any modern desktop. With a National Instuments* data acquisition card, it can simultaneously handle multichannel data acquisition and stimulation, couple biological systems with complex computational models, and record multiple channels to disk - all at microsecond latencies.

To date, RTXI has been used by over 60 labs worldwide and is cited in over 70 publications.

RTXI Real-Time eXperiment Interface
www.rtxi.org





Key features

Modular framework

+ custom RT protocols run via standalone modules.
+ modules are loaded as-needed at run-time.
+ real-time processing is written in C++ and UI elements with the Qt framework.
+ the built-in abstraction model bundles RT functionality under-the-hood.

Free and open-source

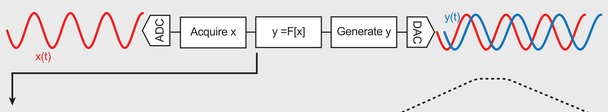
RTXI depends on fully free and open source software:

+ Ubuntu, the Linux distribution
+ Xenomai, the RT microkernel
+ Analogy, the RT DAQ driver

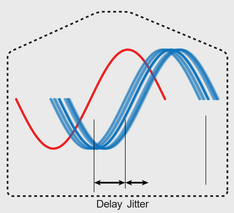
Hard RT performance

At rates up to ~40 kHz, simultaneously:
+ Acquire multiple analog/digital inputs.
+ Compute control signals.
+ Output multiple analog/digital outputs.
+ Record data.

Hard real-time, closed-loop performance

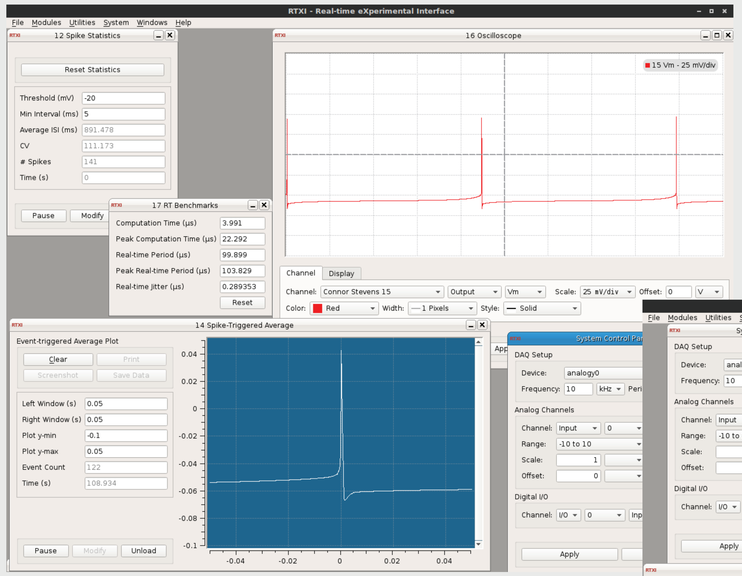


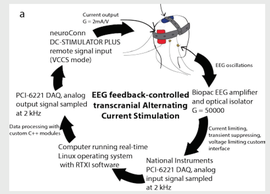
Operation (FLOPs/Cyc.)	Latency (µsec)	Jitter (µsec)
0	~1	~.2
1000	~3	~.5
10000	~6	~ 2
100000	~10	~ 5



The real-time (RT) kernel:
+ preempts the standard kernel.
+ guarantees deterministic loop times with RT threads.
+ uses RTLinux-based biosignal acquisition software.
+ provides an driver interface for hard RT data acquisition.

Platform and interface overview





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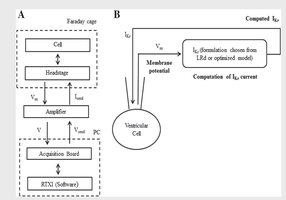

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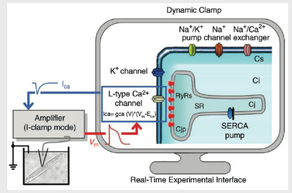

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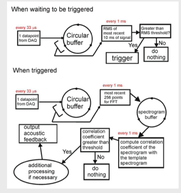

Skocik, Mike, and Alexay Kozhevnikov. “Real-time system for studies of the effects of acoustic feedback on animal vocalizations.” Frontiers in neural circuits 6 (2012).

RTXI resources

rtxi.org (our website) provides:
+ live CDs.
+ installation instructions.
+ tutorials.
+ troubleshooting documentation.
+ a list of publications that used RTXI.

github.com/rtxi (our code repository) for:
+ all RTXI and module source code.
+ tracking issues and bug reports.
+ making feature requests.

We also make available:
+ 24/7 technical support.
+ on-site assistance.

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

Future development

Enable real-time optical methods:
+ support measurement and intervention.
+ a generic camera interface.
+ modules suited for optogenetic experiments.

Build interfaces to multielectrode devices:
+ EGI dense-array EEG devices.
+ TDT amplifiers

Build an open-hardware data acquisition and control board in partnership with OpenEphys.