LabStreamingLayer Overivew

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Swartz Center for Computational Neuroscience

EEGLab Workshop
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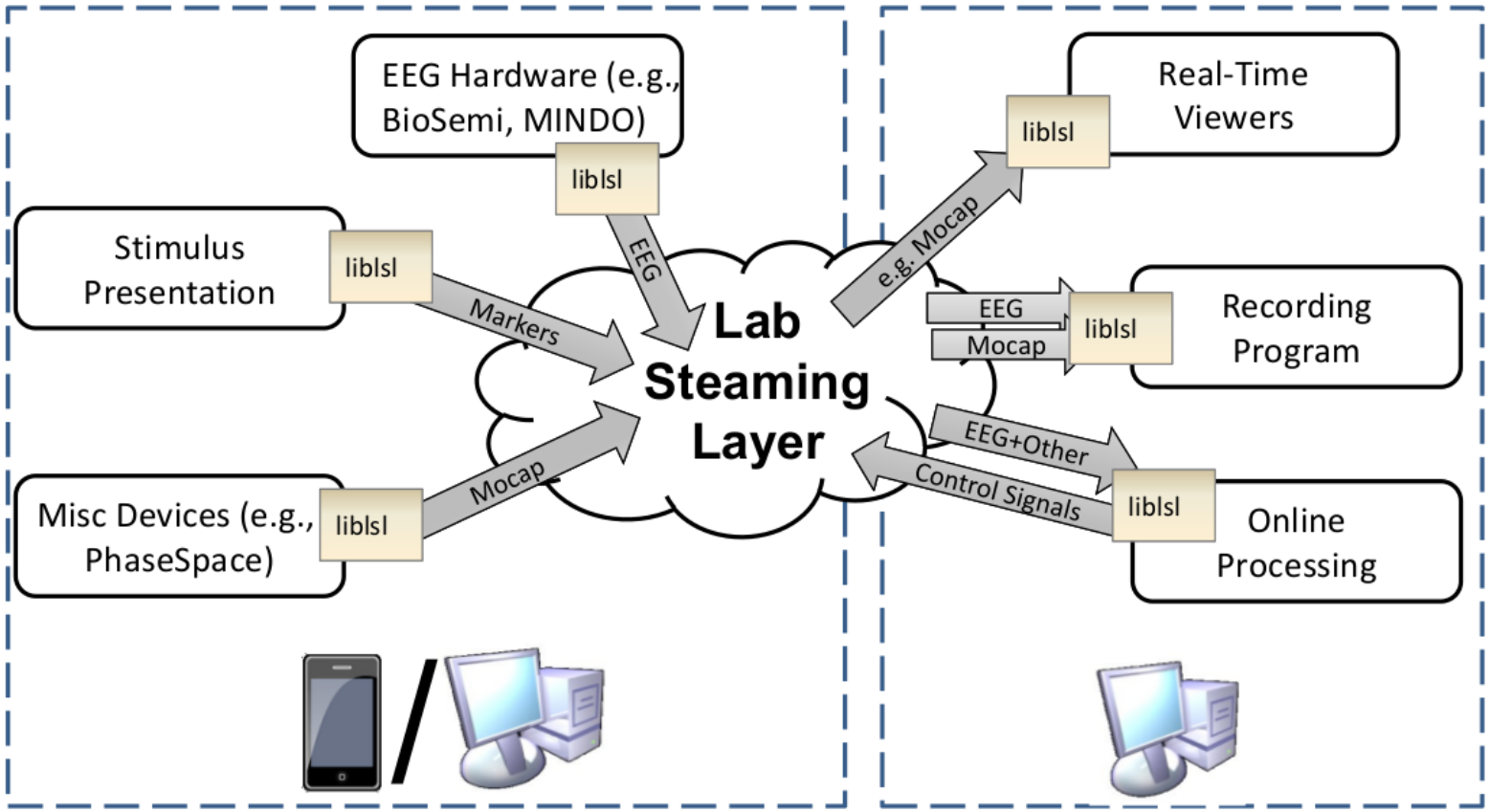
Outline

What is LabStreamingLayer?



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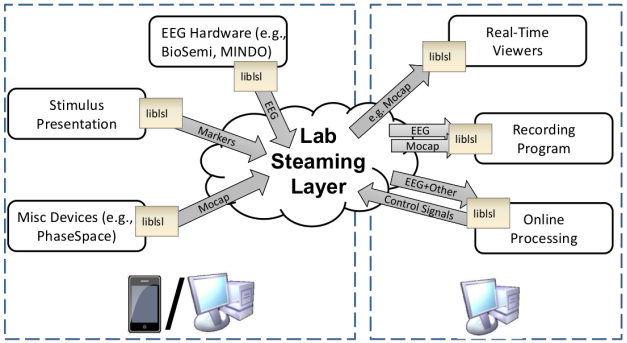

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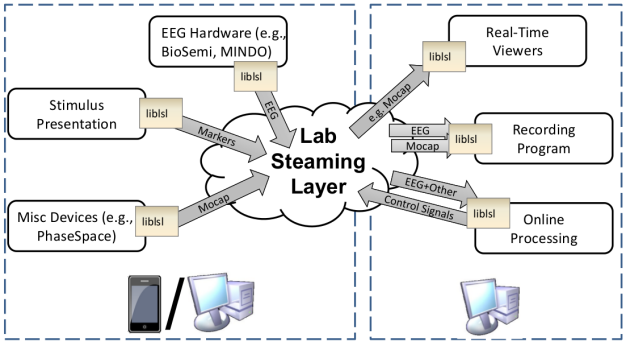

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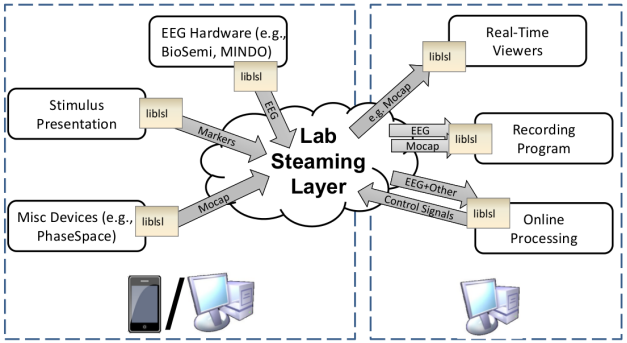

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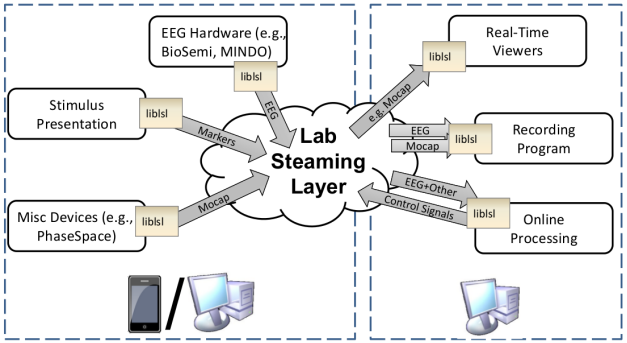

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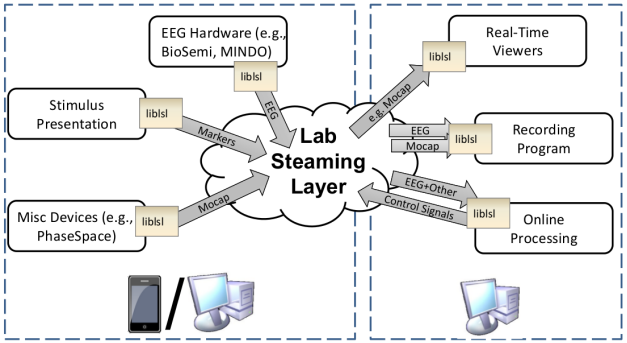
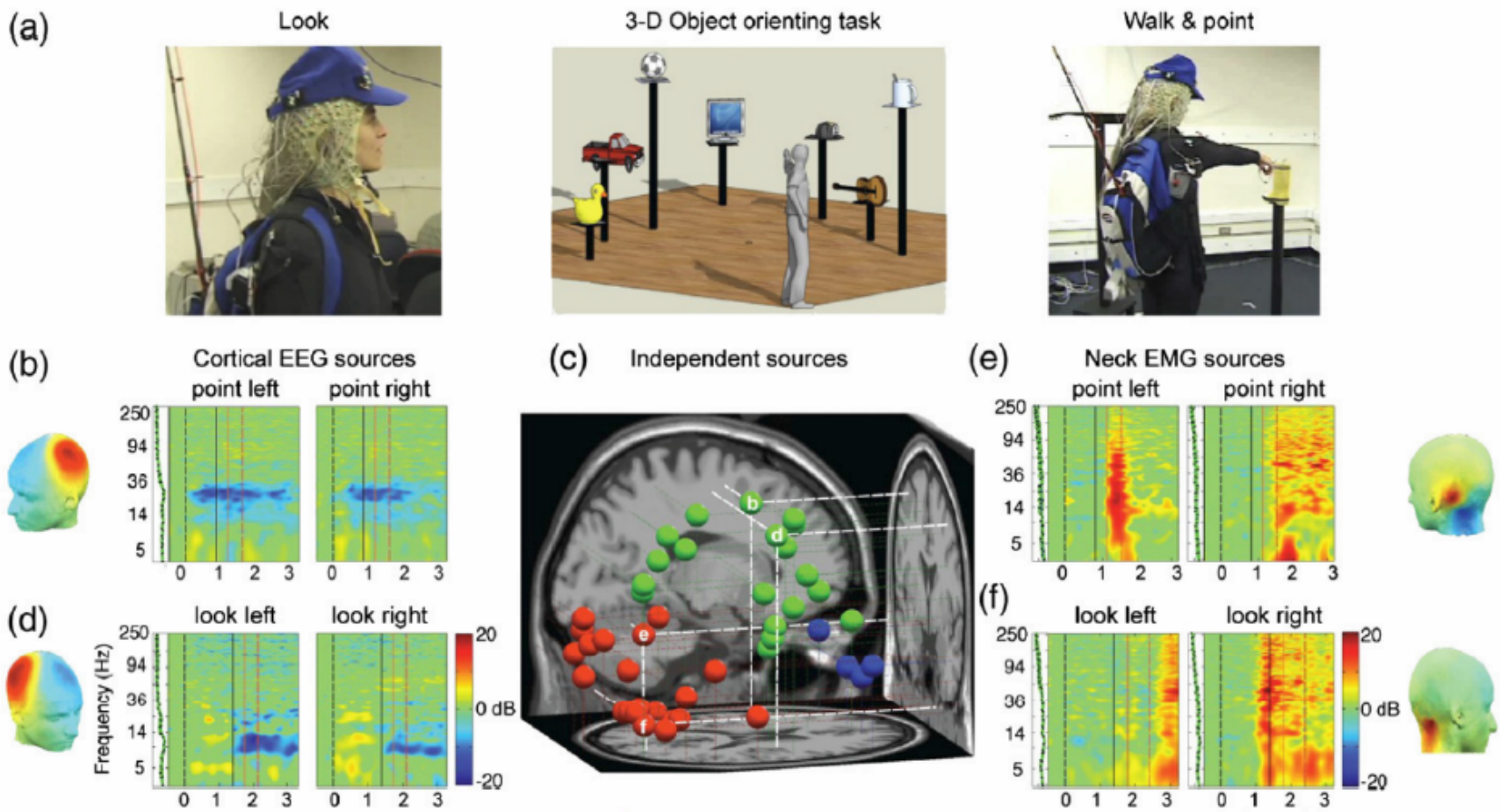


- open source software library
- highly extensible and supports wrappers for numerous languages
- overlay network
- realtime data streaming
- facilitates multimodal data stream synchronization without hardware triggers

Mobile Brain/Body Imaging (MoBI)



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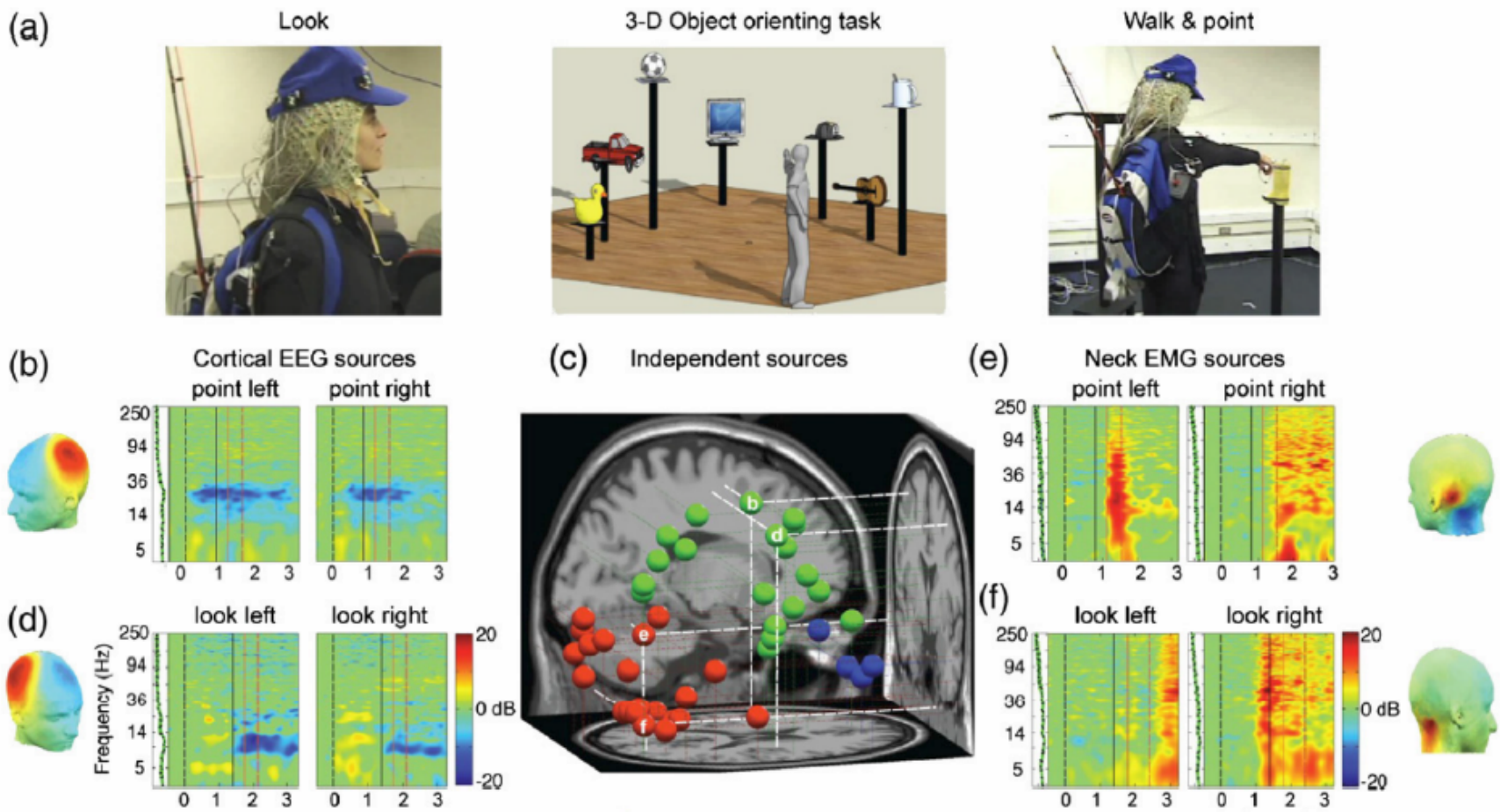
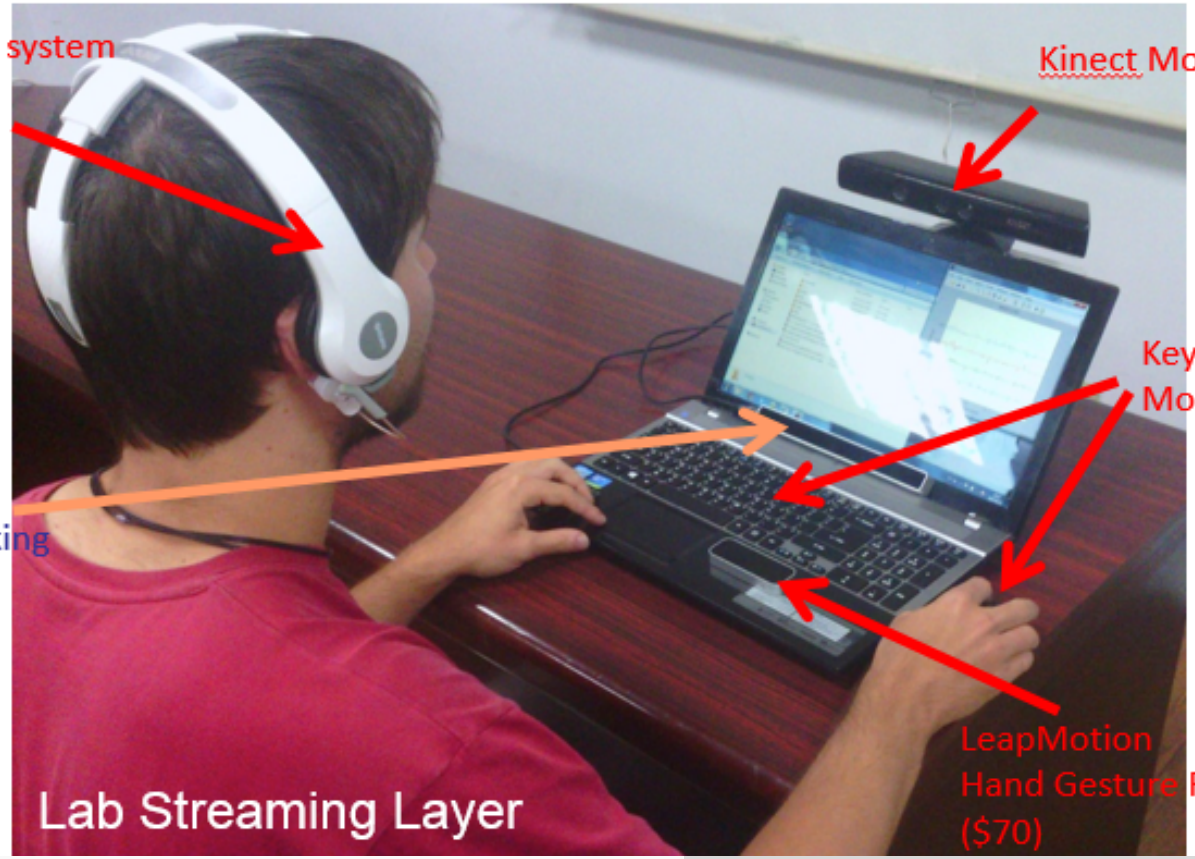
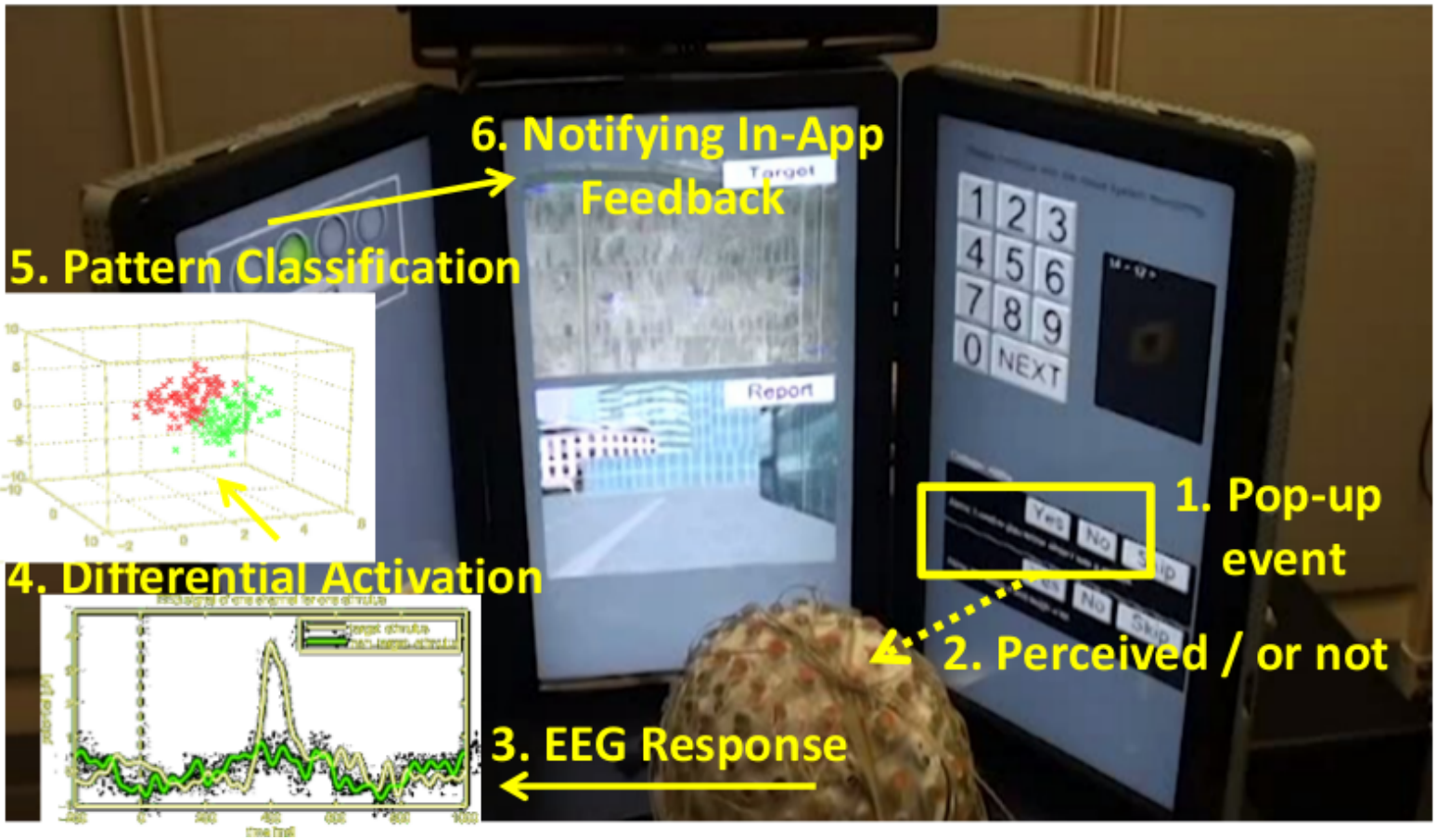


Low-Cost Mobile Brain/Body Imaging (MoBI) Platform



Large Scale Experiments



Synchronizing

EEG and ExG	Full-Body Motion Capture	Eye-Tracking	Human Interface Devices, System State, Etc.

The Challenge: To Synchronize Multiple (Asynchronous) Streams

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- HCI, GSR, Heartrate, Forceplate, etc. ?? Hz

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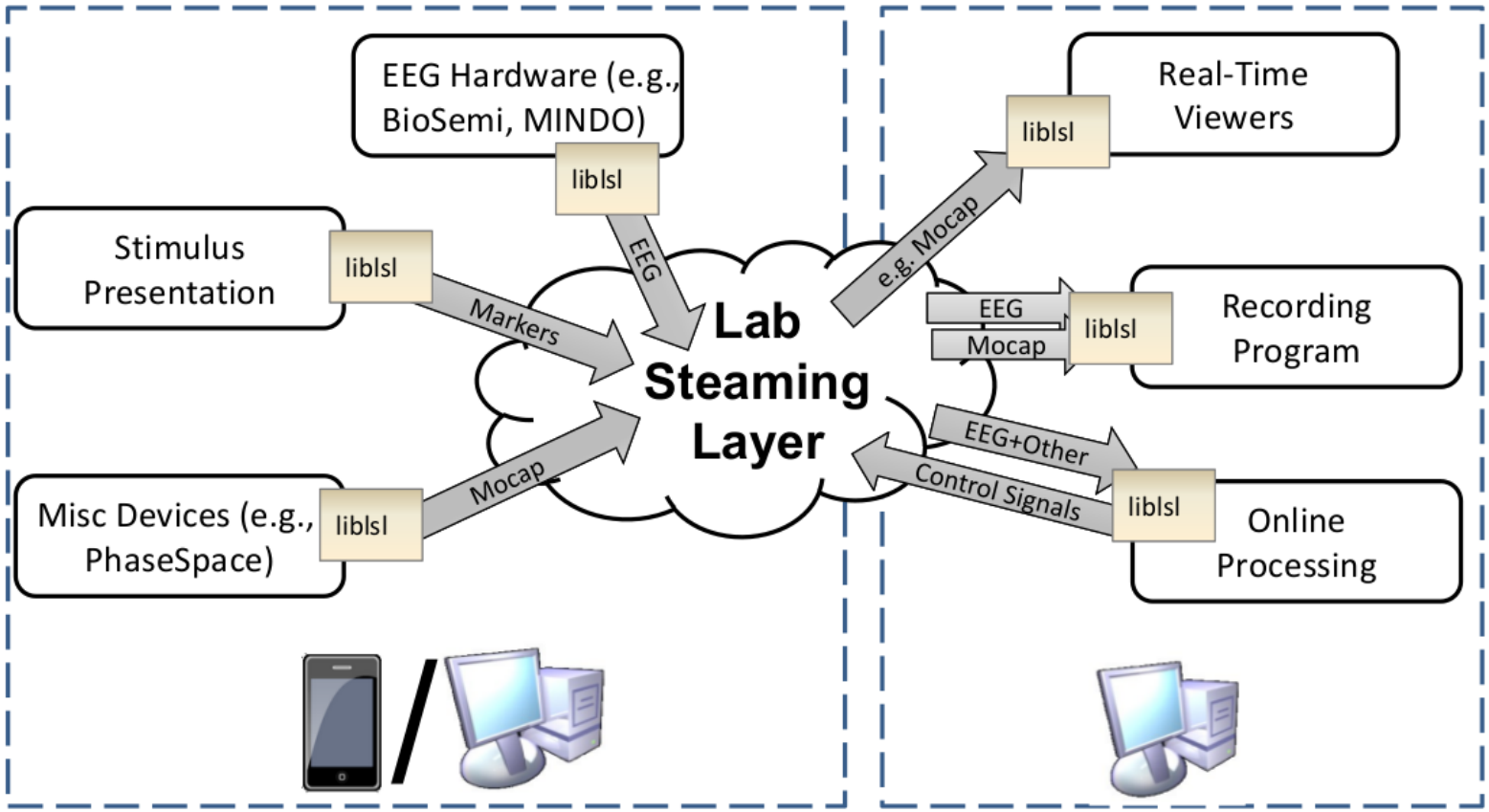
- Attach timestamps to data
- Attach timestamps to record times
- Measue and test EVERYTHING OVER AND OVER

LSL Network View



liblsl

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- Basically provides methods for creating 3 objects:
  - `stream_info` (metadata)
  - `stream_outlet` (send data)
  - `stream_inlet` (receive data)

stream_info constructor params

Specifies the nature of an lsl stream (essentials)

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- name ('ActiChamp')
- type ('EEG')
- channel count ('64')
- sample rate('512')
- format ('float32')
- source Id ('8JIAes263D' some such serial number)

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append meta-data

XML based information that adheres to a basic template, but can be extended to contain anything, anyhow

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- destroy after using...(show some code)

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resolve_stream

Details – `stream_inlet`

`resolve_stream`

- @param prop (‘name’, ‘type’, etc.)
- @param value (‘ActiChamp’, ‘EEG’, etc.)
- @return `std::vector<stream_info>`

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- @return `std::vector<stream_info>`

`stream_inlet` constructor

- @param info (one of the `stream_info` objects returned by `resolve_stream`)
- (optional) @params buffer length, chunk length, recover (bool)

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- destroy when all done (show some code)

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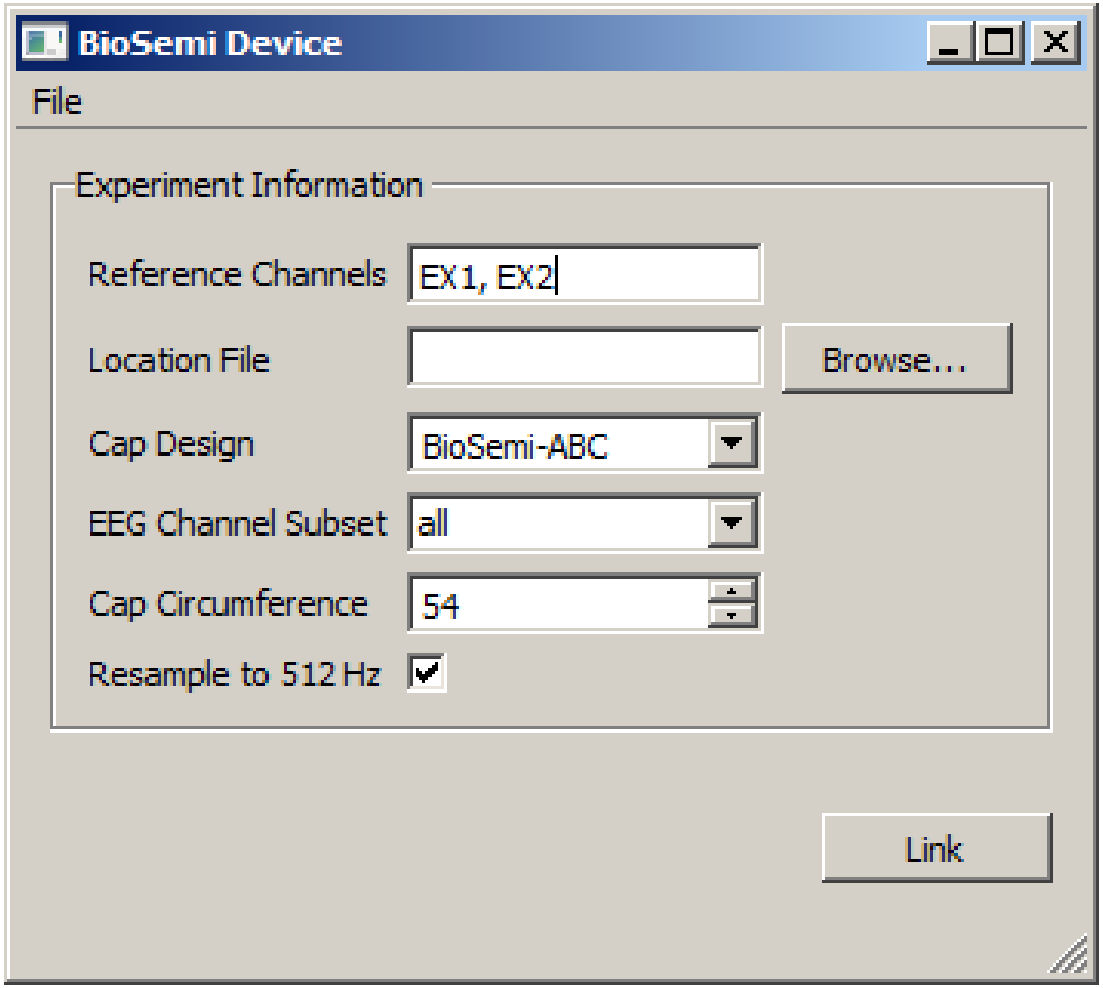
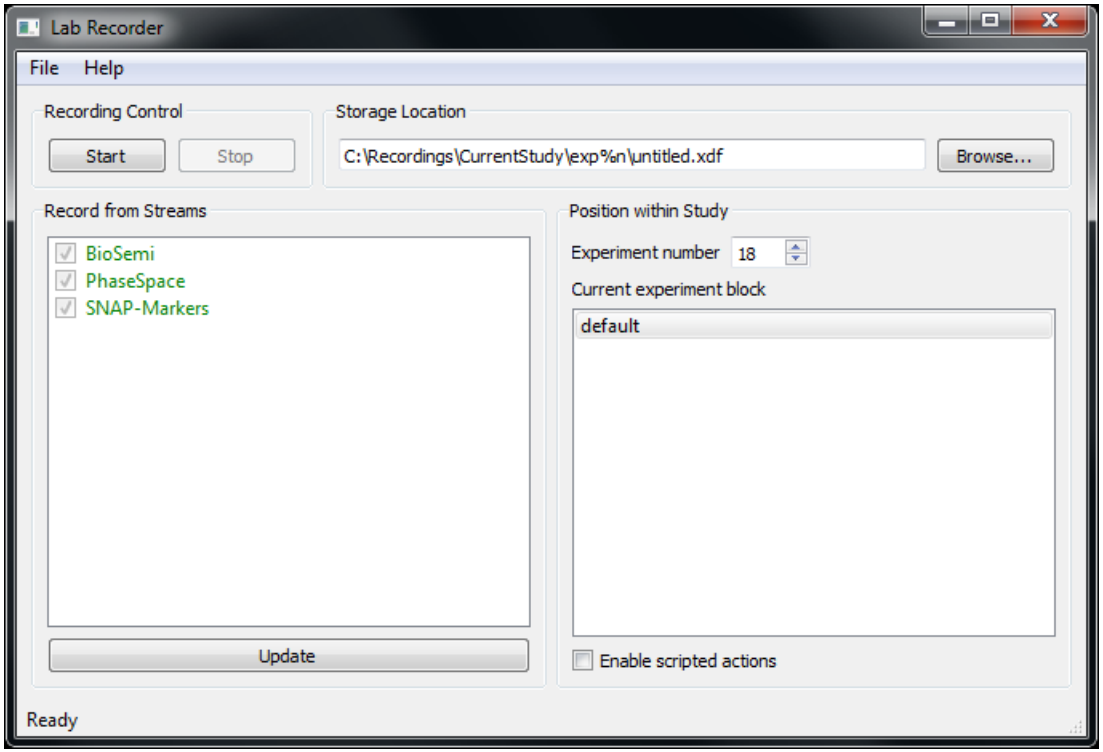
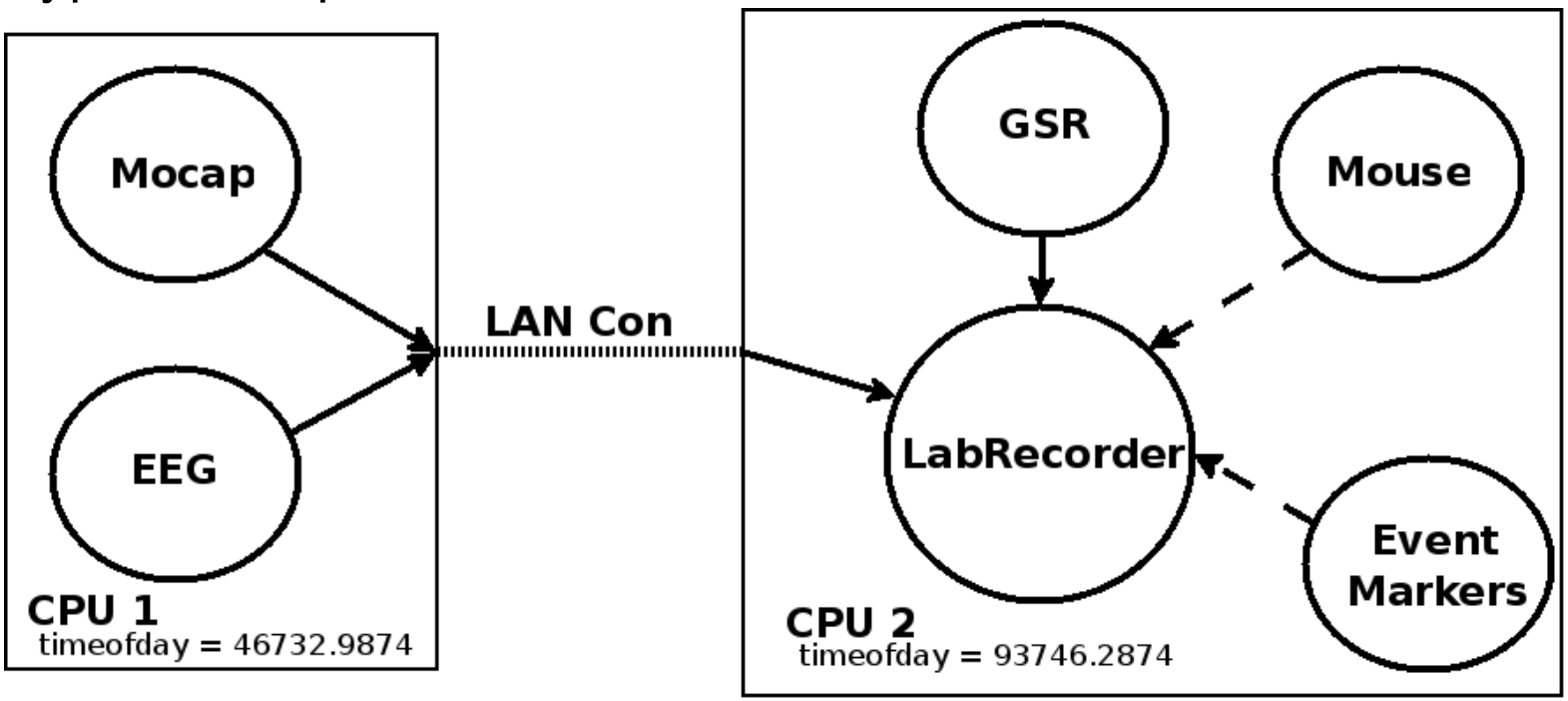
- Setup ‘streaminfo’ and metadata (xml)
- Open LSL ‘outlet’
- Launch listener thread to ‘push’ LSL data as it arrives


BioSemi Device
File
Experiment Information
Reference Channels
EX1, EX2
Location File
Browse...
Cap Design
BioSemi-ABC
EEG Channel Subset
all
Cap Circumference
54
Resample to 512 Hz
Link

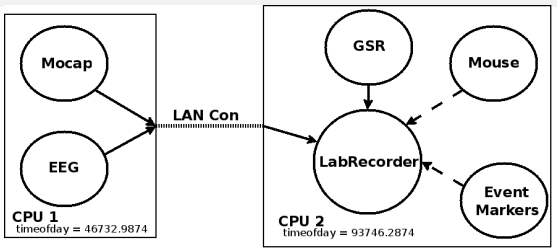
Overview – Apps



Typical Setup:



Overview – LabRecorder and load_xdf.m



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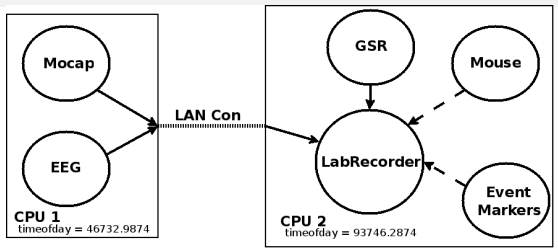

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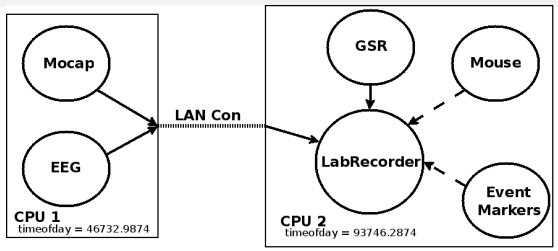

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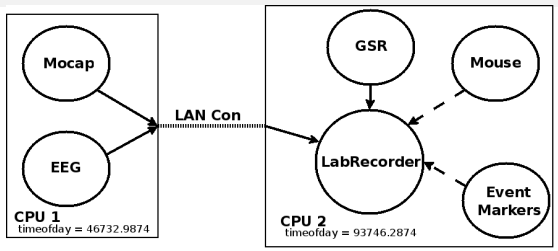

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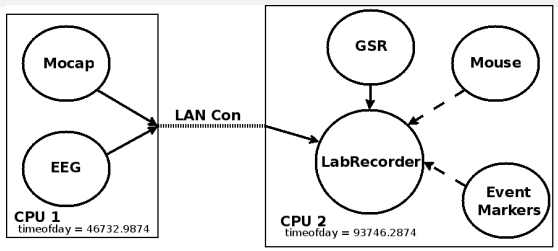

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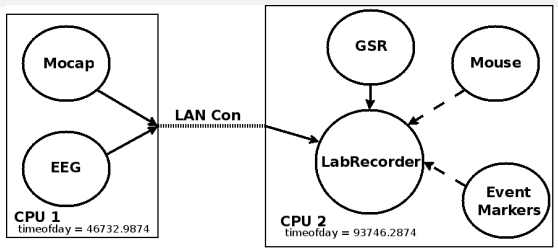

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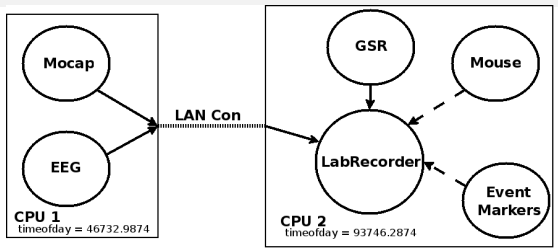

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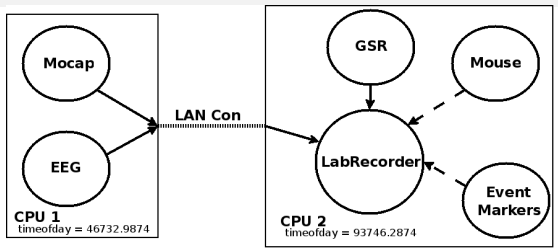

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- Organize meta-data into a datastructure
- Linearize non-sporadic timestamps
- Use clock offsets and known latencies to synchronize data streams

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  - receove from outlet at inlet (t4)
- round trip time (RTT) = (t3-t0) - (t2-t1)
- clock offset (OFS) = ((t1-t0) + (t2-t3))/2 (for lowest RTT)

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- This is normally done post-hoc in `load_xdf.m` using a fitting procedure. Each map is calculated using an ADMM method incorporating the Huber loss function (`http://www.stanford.edu/~boyd/papers/distr_opt_stat_learning_admm.html`)
- Each map is a DC offset and a slope adjustment ($y_n = ax_n + b$) for each intermittent OFS record point (default is 5s between queries).

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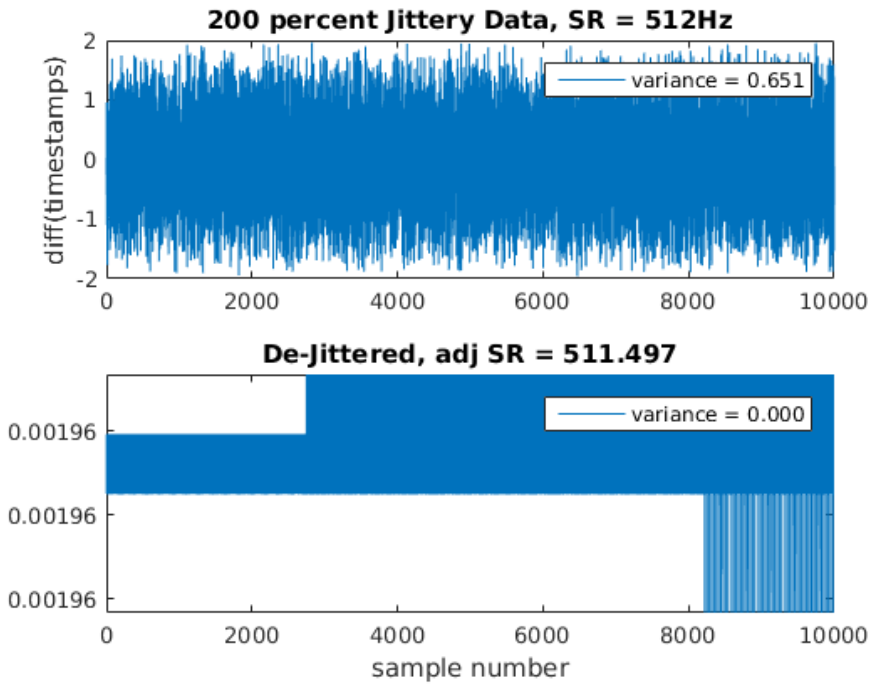
- Each map is a DC offset and a slope adjustment ($y_n = ax_n + b$) for each intermittent OFS record point (default is 5s between queries).
- The latest version of LSL has methods for doing this online, but it is not yet validated

3: Linearize/De-Jitter the timestamps (if appropriate)

- Simple linear regression is very robust:



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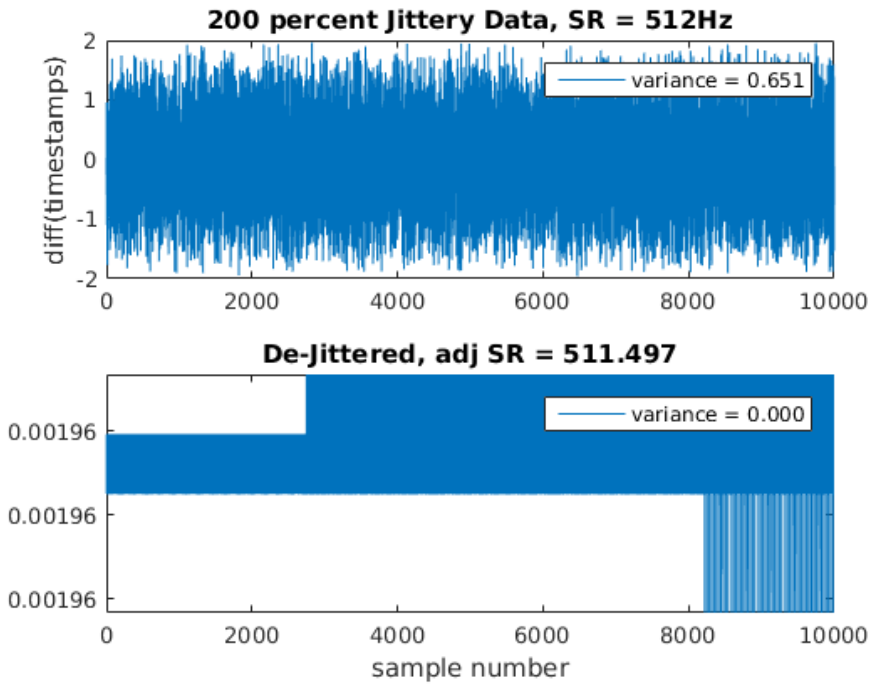

This will fail if the sampling rate changes!

This is bad:

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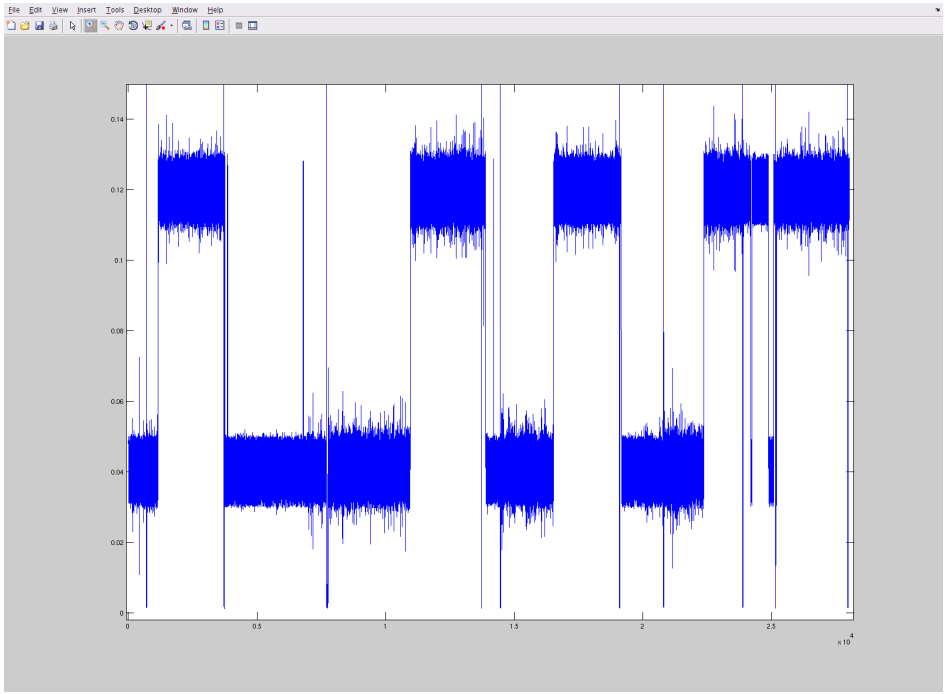
File Edit View Insert Tools Desktop Window Help
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
0.5
1
1.5
2
2.5
x 10^4

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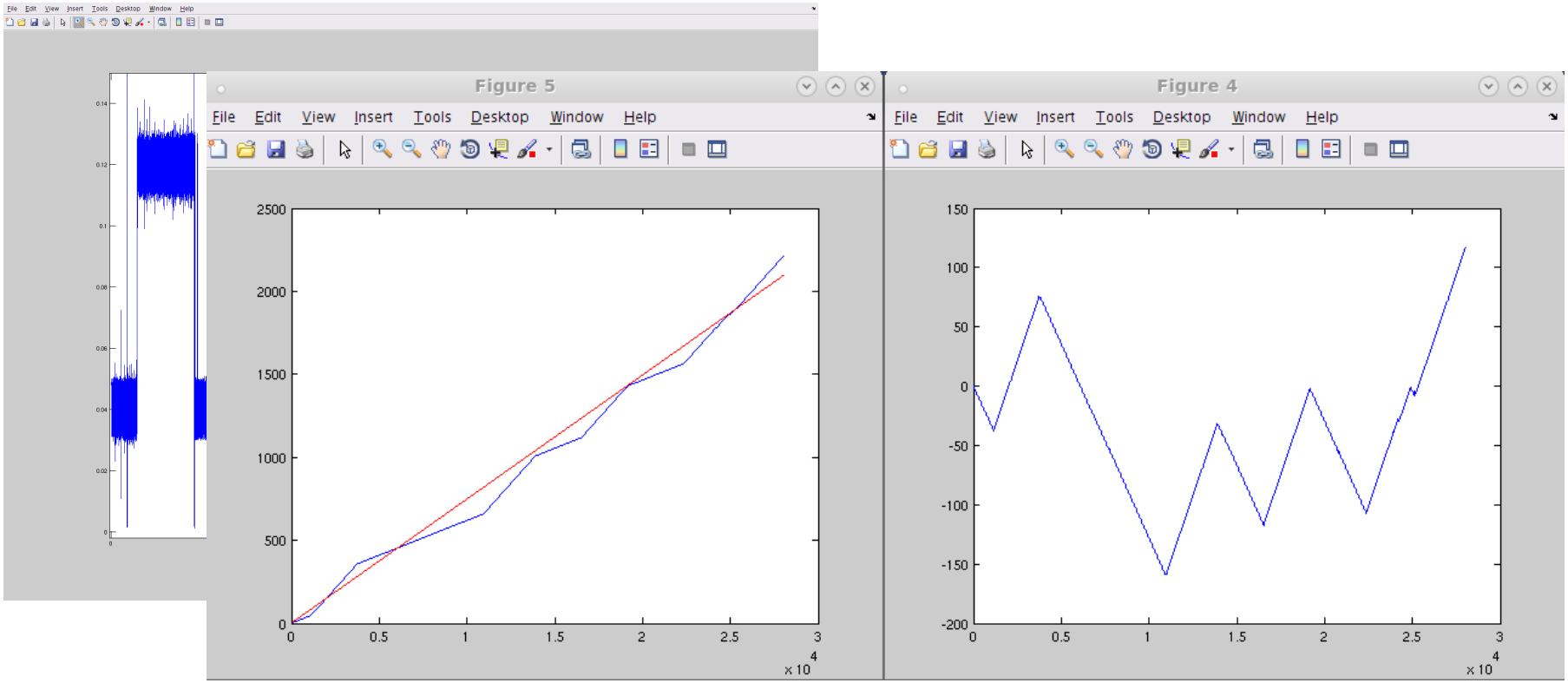

Red line is linearized timestamps, blue is raw. On the right is the difference: between +/-150s !!! .

Determine device Lag:

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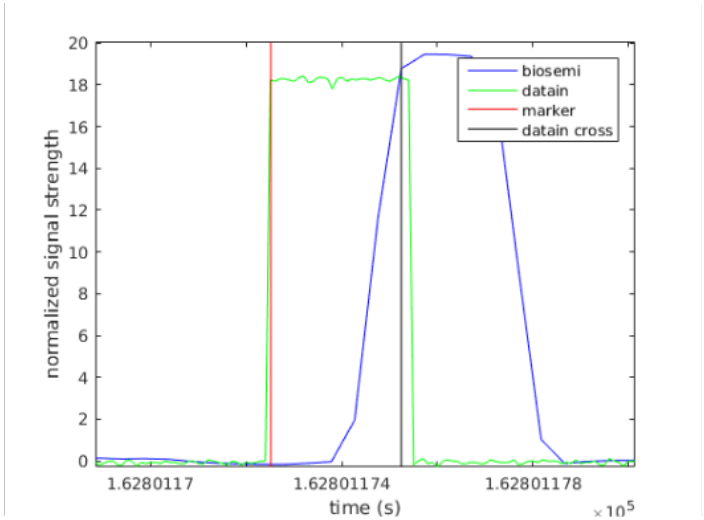
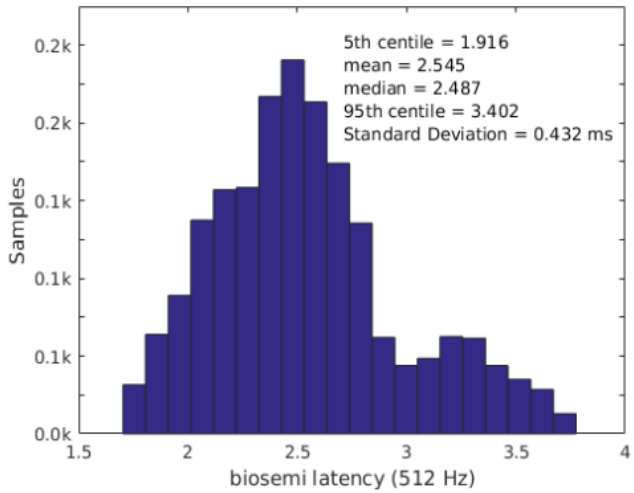
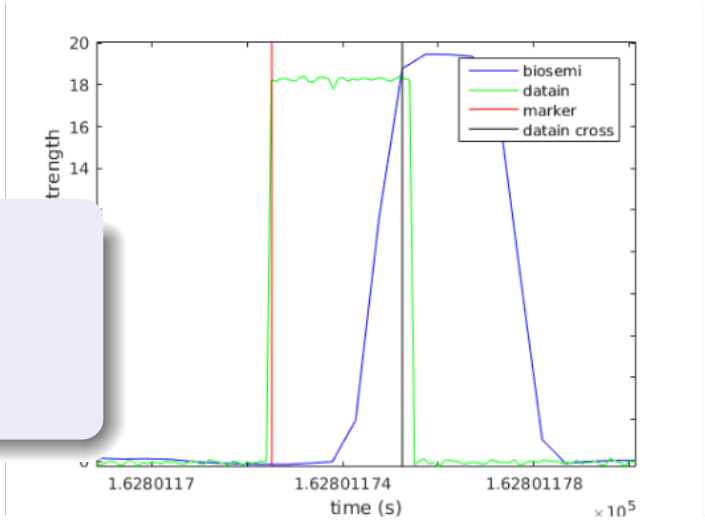
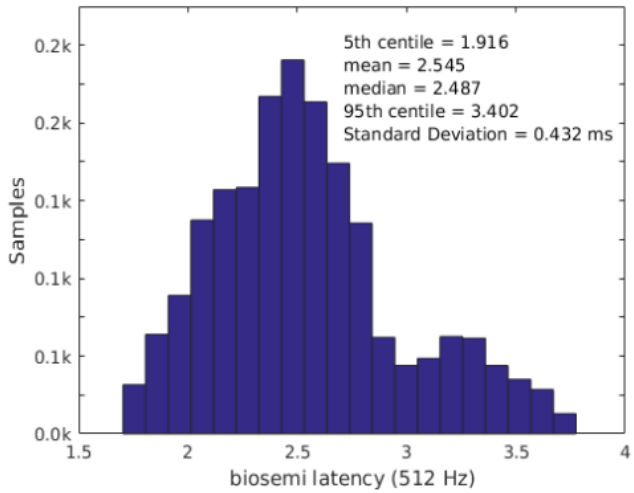


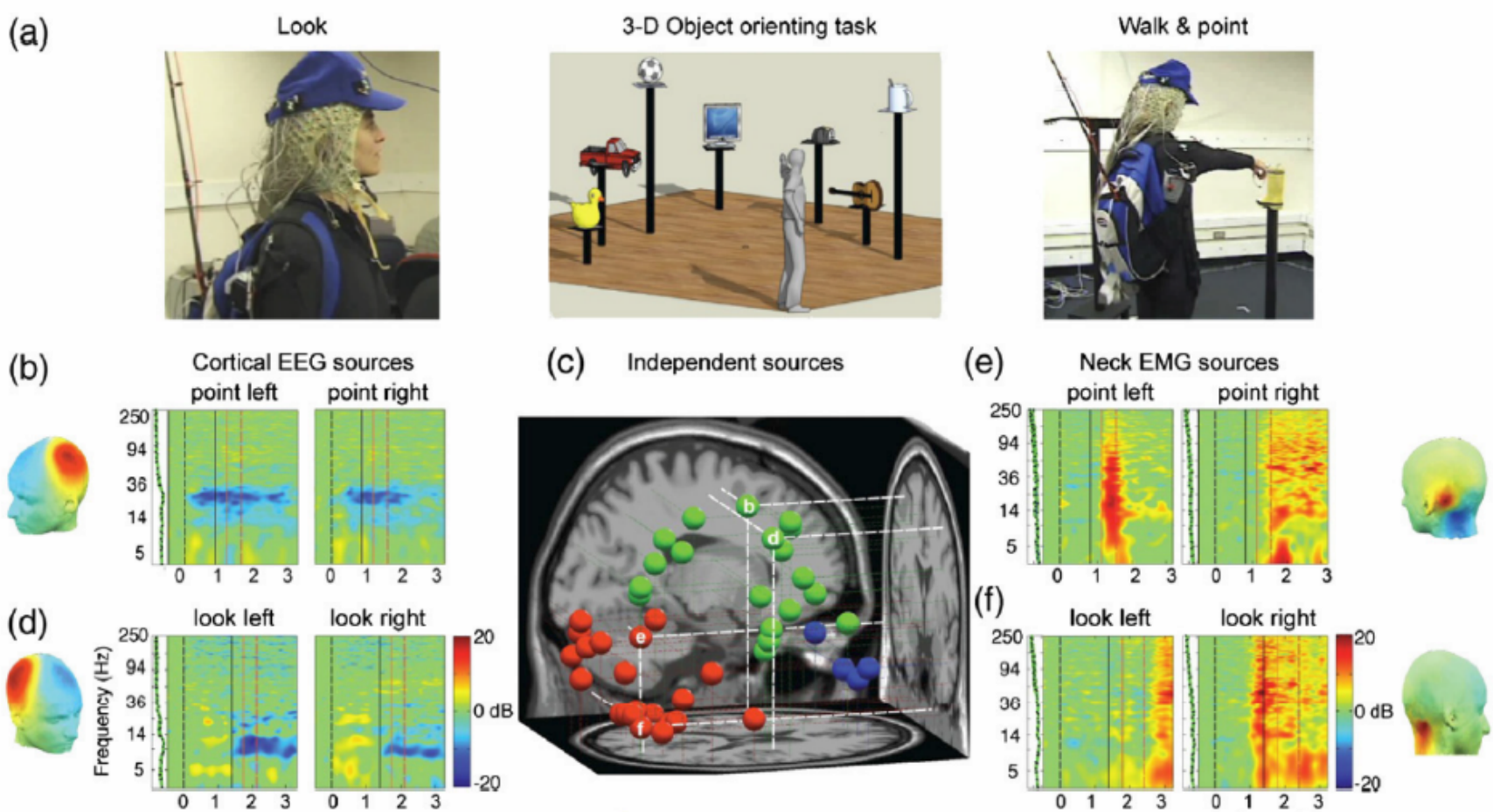


Determine device Lag:

To complete the synchronization, simply subtract the mean.






(a)
Look
3-D Object orienting task
Walk & point
(b)
Cortical EEG sources
point left
point right
(c)
Independent sources
(e)
Neck EMG sources
point left
point right
(d)
look left
look right
Frequency (Hz)
250
94
36
14
5
0 1 2 3
20
0 dB
-20
(f)
look left
look right

Thank You!