Demo 1: The Lab Streaming Layer

Introduction to Modern Brain-Computer Interface Design

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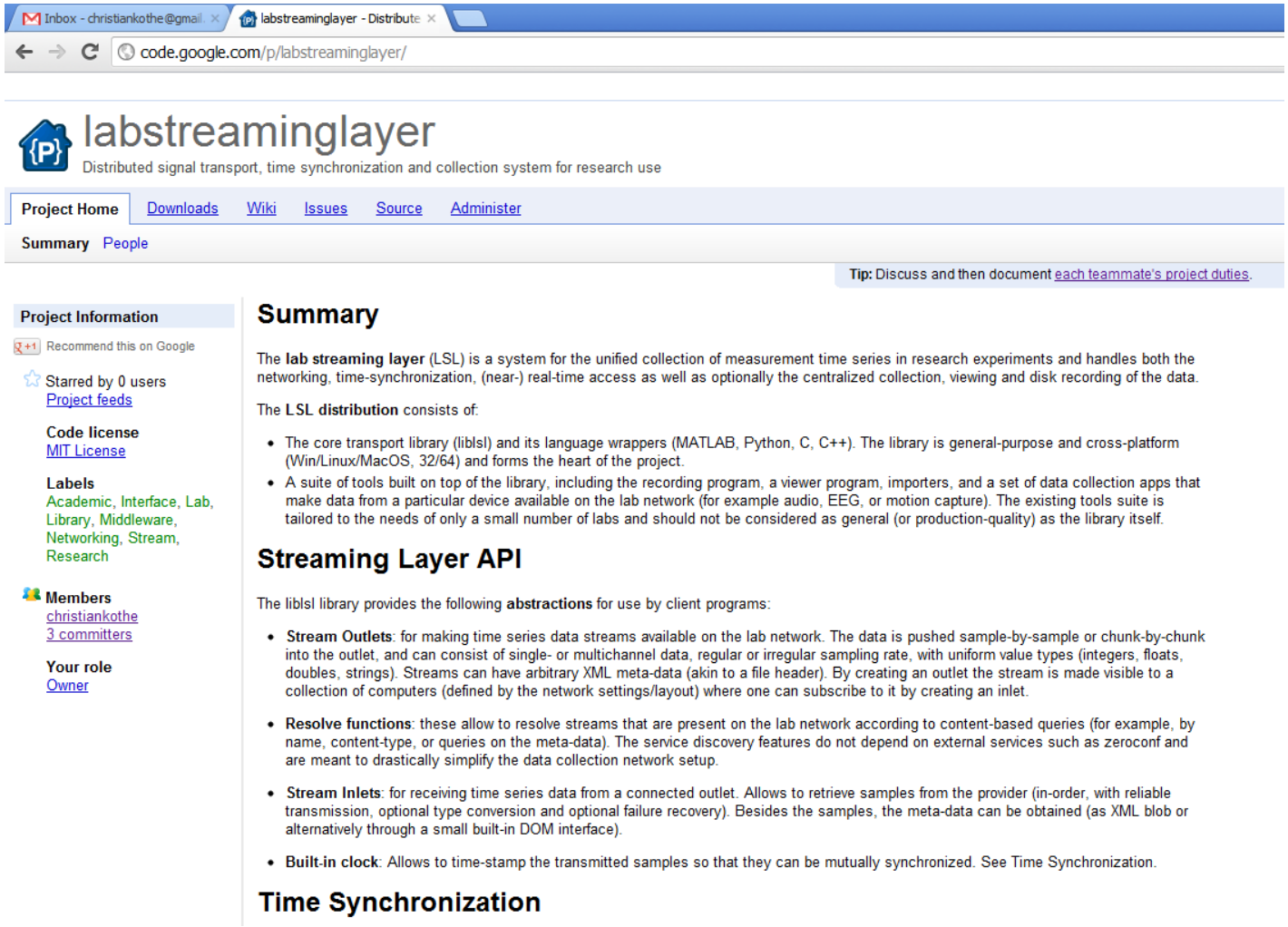
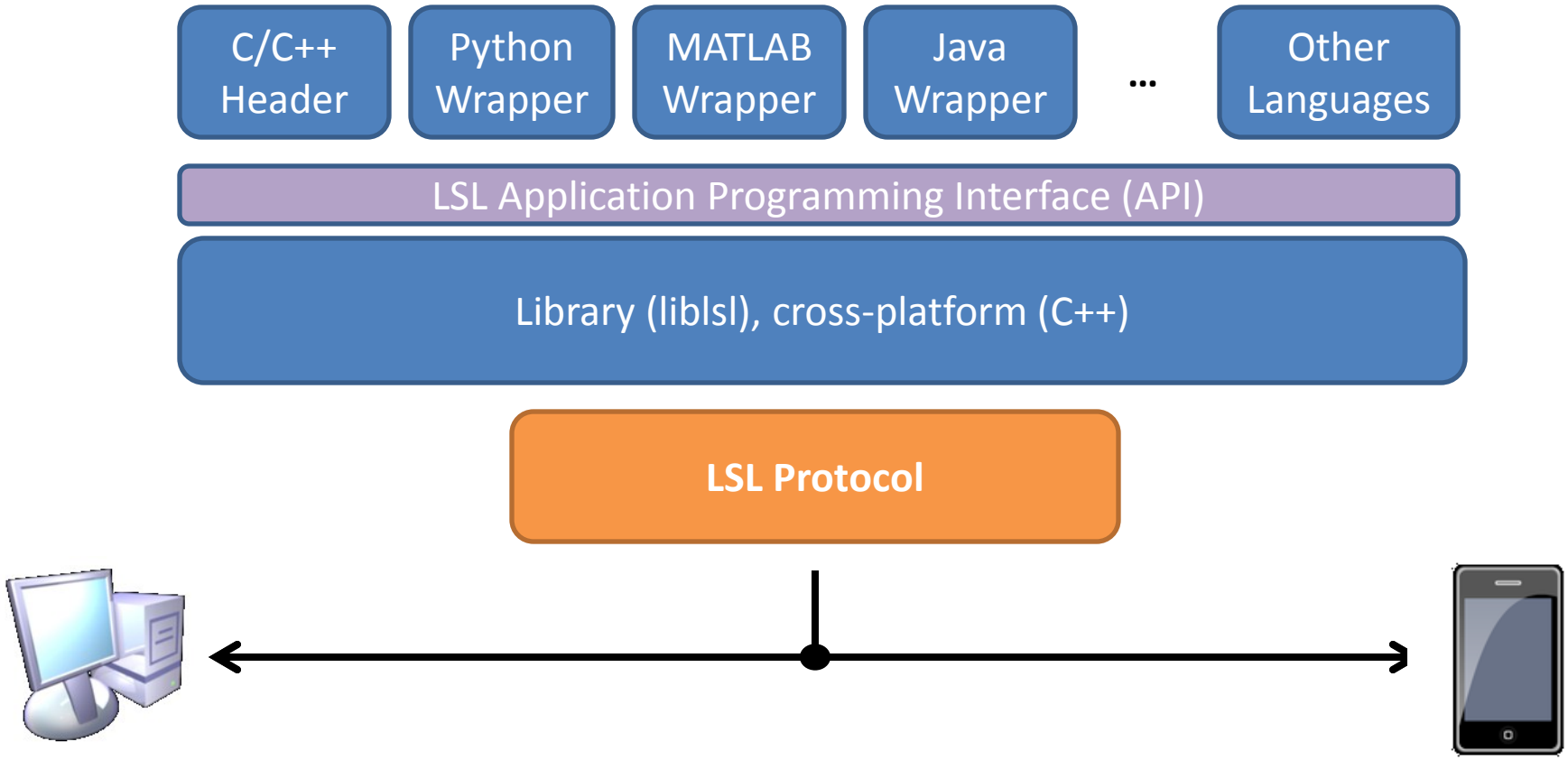
The Lab Streaming Layer



code.google.com/p/labstreaminglayer

LSL Core Components

- Low-level technology for exchange of time series between programs and computers



LSL Software Distribution

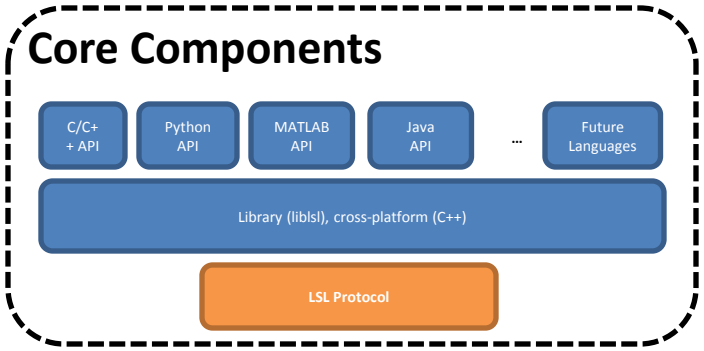
- Includes Documentation, User Guides, Example Programs, Acquisition Programs, Generic Tools
- Everything is open source (MIT-licensed)

Acquisition Programs (EEG, Eye tracking, Human Interfaces, Motion Capture, Multimedia)

Generic Viewers, Recorder

Example Programs

Wiki Documentation



Supported Hardware

- **EEG**: Biosemi, Cognionics, MINDO , EGI AmpServer, BrainProducts, g.USBamp, Emotiv, Micromed, MindMedia, OpenEEG, TMSi, ANT Neuro ASALAB
- **Eye Tracking:** SR Research EyeLink, custom 2-camera setup
- **Motion Capture:** PhaseSpace, OptiTrack, Kinect, AMTI Force Plates
- **Human-Interface Devices:** Mice, Keyboards, Trackballs, Game Controllers, Wiimote and Expansions
- **Multimedia Devices:** PC-compatible sound cards, DirectShow-compatible video hardware
- **Untested:** ABM B-Alert, Enobio, Neuroscan Synamp, Tobii, SMI iViewX, Mitsar EEG, CTF/VSM

*: most devices currently require Windows

Providing Data to LSL

```
% instantiate the library
lib
    imp
    imp
% I
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% s
whi
    out

    pri
end
```

```
import sys; sys.path.append('..') # make sure that pylsl is found (note: in a
#include "../../../include/lsl_cpp.h"
#include <stdlib.h>
using namespace lsl;

# f /**
# T  * This is an example of how a simple data stream can be offered on t
   * The transmitted samples contain random numbers (and the sampling r
samples).
   */
# r int main(int argc, char* argv[]) {

        // make a new stream_info (128ch) and open an outlet with it
        stream_info info("SimpleStream","EEG",128);
        stream_outlet outlet(info);

        // send data forever
        float sample[128];
        while(true) {
                // generate random data
                for (int c=0;c<128;c++)
                        sample[c] = (rand()%1500)/500.0-1.5;
                // send it
                outlet.push_sample(sample);
        }

        return 0;
}
```

```
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other more or

dsffwerwer');

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,random.random
```

Receiving Data from LSL

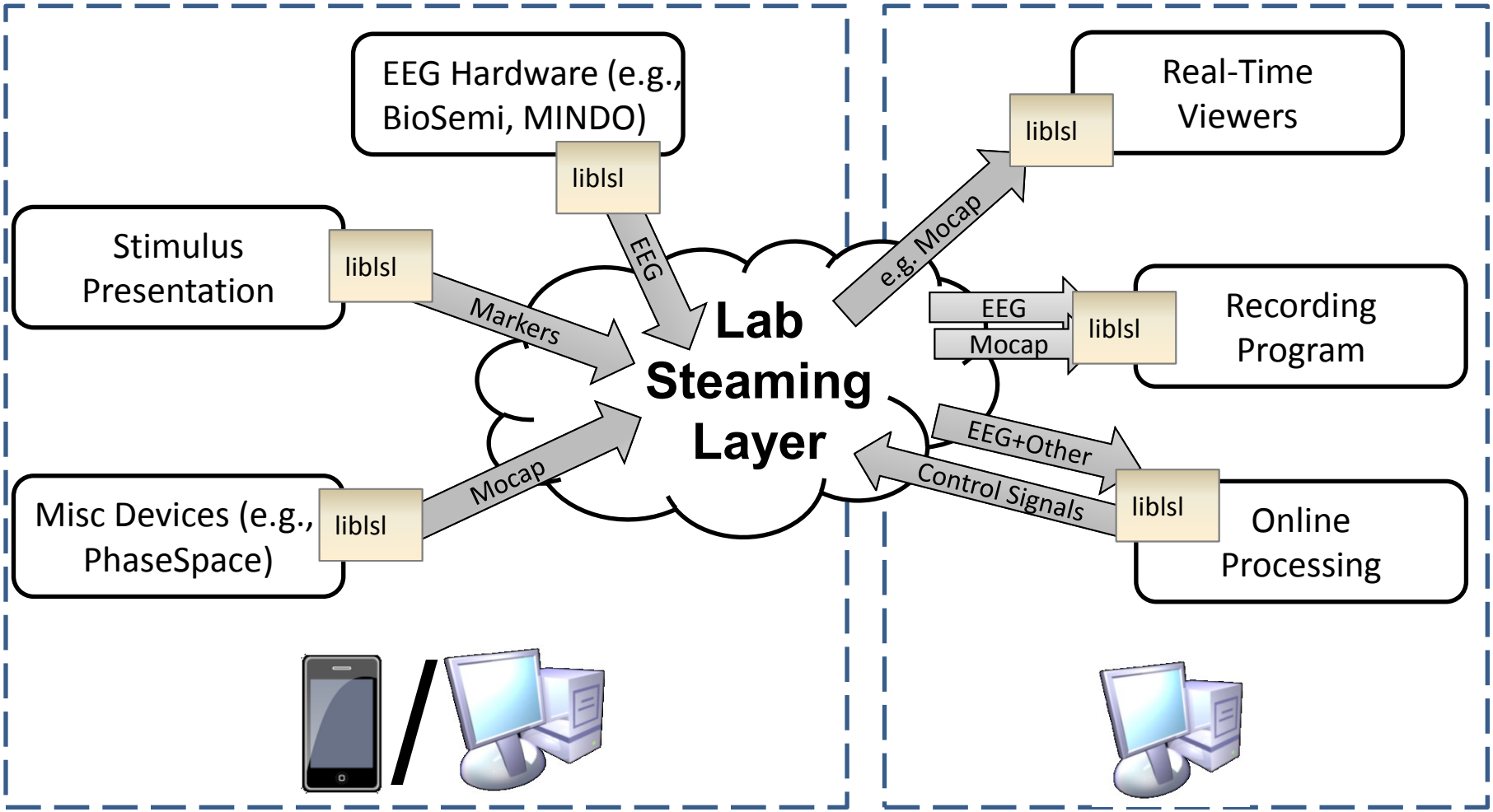
```
% instantiate the library
lib = lsl_loadlib();

% try resolve an EEG stream...
result = {};
while isempty(result)
    result = lsl_resolve_byprop(lib,'type','EEG'); end

% create a new inlet from the first result
inlet = lsl_inlet(result{1});

while true
    % get data from the inlet and print it
    [vec,ts] = inlet.pull_sample();
    fprintf('%.2f\t',vec); fprintf('%.5f\n',ts);
end
```

Network View



Hands-On Section

Swartz Center for Computational Neuroscience

D1 Questions?