WebCL Overview and Roadmap

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WebCL Motivation

- **Enable high performance parallel processing on GPU/multicore by web applications.**
- **Portable and efficient access to heterogeneous multicore devices.**
- **Platform independent, efficient and standards compliant solution.**
  - Leverage device's multicore/parallel computing resources from web-based apps.
- **Integration of OpenCL capabilities in the JavaScript environment.**
  - Enhanced performance (comparable to native OpenCL).
- **Enable a breadth of interactive web applications with high compute demands, on mobile platforms with multicore resources.**
  - E.g. apps: Object Recognition, Speech Recognition, Gaming, Augmented Reality, etc.

WebCL Design Goals

- **Enable general purpose parallel programming on heterogeneous processing elements, with following design philosophy:**
  - A single coherent standard across desktop and mobile devices.
  - Open, royalty-free standard for general purpose parallel programming.
  - Encourage openness with public specification drafts, mailing lists, forums, etc.
    - Public and Khronos mailing lists and Wiki to facilitate discussion.
      - webcl_public@khronos.org
      - https://www.khronos.org/webcl/wiki/Main_Page
  - Design with security as #1 focus.

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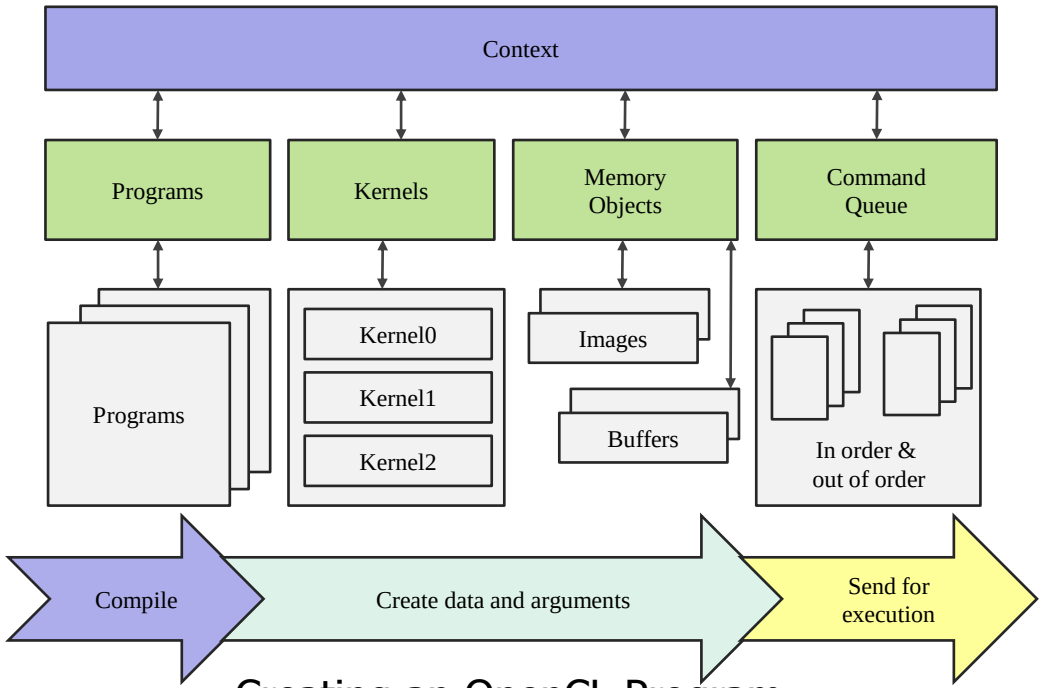
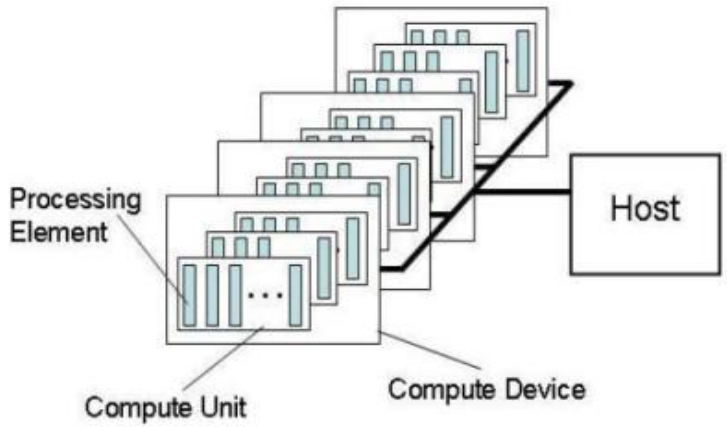
WebCL HW and SW Requirements

- **WebCL will require a modified browser with OpenCL/WebCL support.**
- **Hardware, driver and runtime support for OpenCL.**
- **OpenCL program flow and OpenCL platform model:**



Creating an OpenCL Program



OpenCL Platform Model

WebCL Approach

- **Stay close to the OpenCL standard.**
  - To preserve developer familiarity and to facilitate adoption.
    - Allow developers to translate their OpenCL knowledge to web environment.
    - Easier to keep OpenCL and WebCL in sync, as the two evolve.
- **Intended to be an interface above OpenCL.**
  - Facilitate layering of higher level abstractions on top of WebCL API
- **Design with focus on security.**
- **Portable by design.**
  - Simplification of initialization to promote portability.

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WebCL Status and Roadmap

Status:

- **Khronos BoD approved the creation of WebCL Working Group-May 2011.**
- **Nokia and Samsung made their prototype implementations open source.**
  - WebCL standard is currently being defined by Khronos.

Roadmap:

- **An online specification and IDL.**
  - A WebCL Reference Card
  - WebCL logo and rules of use
- **Implementation document on guidelines for layering WebCL on OpenCL.**
- **Definition of conformance process.**
  - A conformance test suite for testing WebCL implementations
- **Security will remain #1 priority for WebCL.**
  - WebCL WG will publish security guidelines.

Design with Focus on Security

- **Security is the highest priority for WebCL.**
  - WebCL will be designed for security.
  - Hardening for WebCL will be promoted and enabled.
- **Ensure that new functionality in the browser does not increase its exposure to attacks.**
- **Near Term:**
  - Provisions to promote robustness.
- **Longer Term:**
  - Work with OpenCL device vendors, driver vendors and browser vendors for an in-depth secure solution, and hardware/firmware supported multi-tasking.

Nokia's WebCL Prototype

- Nokia open sourced their prototype in May 2011 (LGPL).
- Web-based interactive photo editor utilizing GPU for image processing, through WebGL & Nokia's OpenCL bindings for JavaScript.
- YouTube Demo: http://www.youtube.com/watch?v=9BF7zzUM1kY
- Add-on for Firefox 4 on Win/Linux(Firefox 5 coming soon)
- Visit http://webcl.nokiaresearch.com for binaries, source code, demos and tutorials.

Samsung WebCL Prototype

- **Samsung open sourced their prototype WebCL implementation for WebKit in July 2011 (BSD license).**
- **Allows JavaScript to run computations on GPU.**
- **Demos on YouTube:** http://www.youtube.com/user/SamsungSISA
  Demos use WebGL for 3D rendering.
  - Computing N-Body gravitational interactions.
  - Computing surface deformations using a fractal noise function.
- **Code available at** http://code.google.com/p/webcl/
  - For comparison, same computations were also done in pure JavaScript.
  - WebCL gave performance increases of up to 100x.
  - Test Platform: MacBook Pro with NVIDIA GPGPU.

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Samsung WebCL Prototype (cont.)

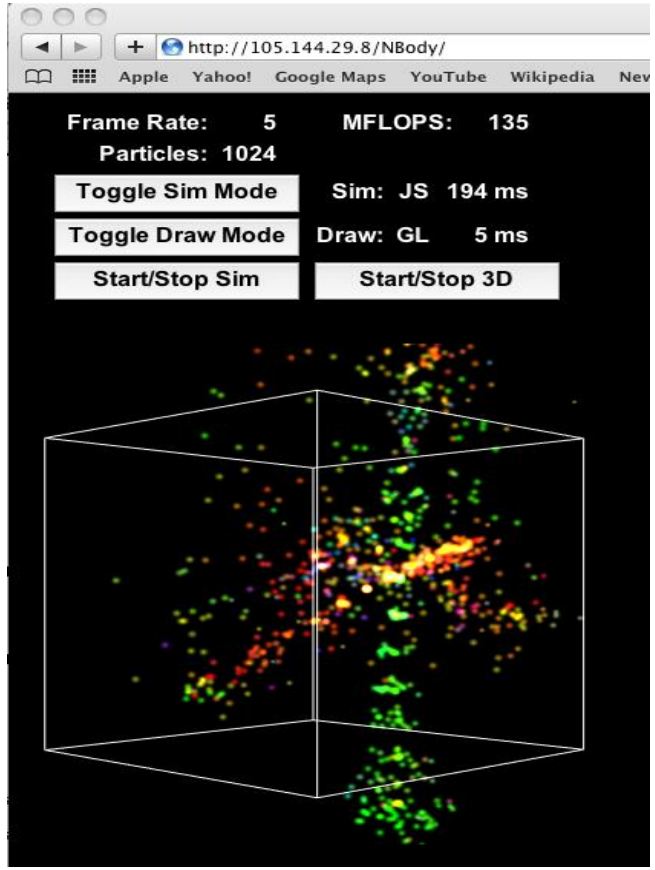
- **OpenCL to WebCL Mapping:** Samsung's WebCL prototype implementation attempts to provide for nearly 1:1 mapping with OpenCL.
  - OpenCL APIs are accessed from JavaScript through the WebCLComputeContext class.
  - Mapping OpenCL to WebCL: cl = new WebCLComputeContext ( )

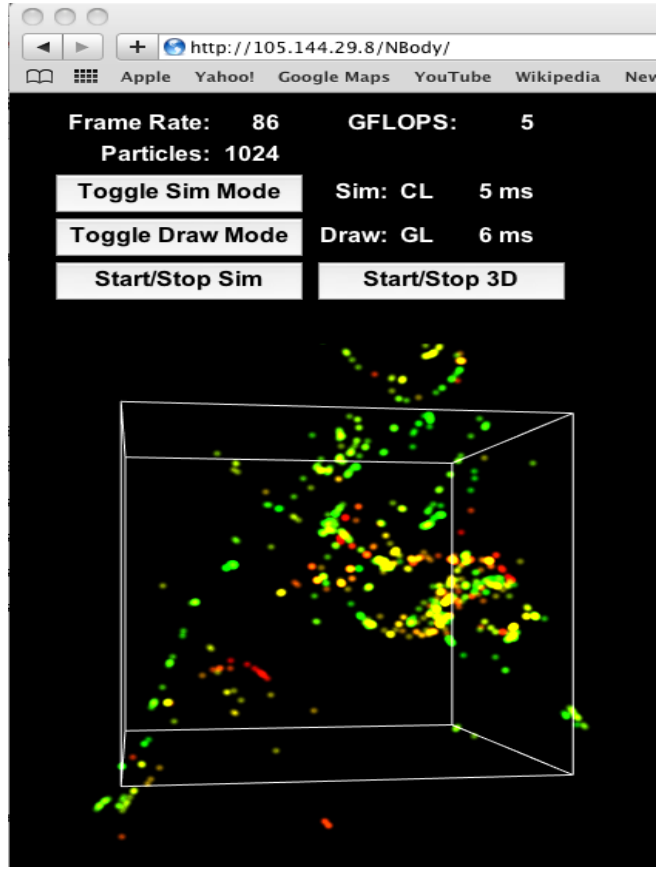
OpenCL - WebCL API Syntax Examples		
OpenCL API	**WebCL API**	**Calling WebCL APIs from JS**
cl_kernel **clCreateKernel** (cl_program program, const char *kernel_name, cl_int *errcode_ret);	WebCLKernel **createKernel** (WebCLProgram*, const String&);	**cl.createKernel** (…)
cl_mem **clCreateBuffer** (cl_context context, cl_mem_flags flags, size_t size, void *host_ptr, cl_int *errcode_ret);	WebCLBuffer **createBuffer** (WebCLContext context, cl_mem_flags flags, size_t size, ArrayBuffer host_ptr);	**cl.createBuffer** (…)

Samsung WebCL Prototype Demo

N-Body Simulation:

- Calculates the positions and velocities of N particles and animates them
- Two simulation modes: JavaScript and WebCL
- Two drawing modes: JavaScript and WebGL with 2D/3D rendering option
- For 1024 particles, WebCL gets 20~40x faster simulation time on Mac
- http://www.youtube.com/user/SamsungSISA#p/a/u/0/F7YSQxz3j7o

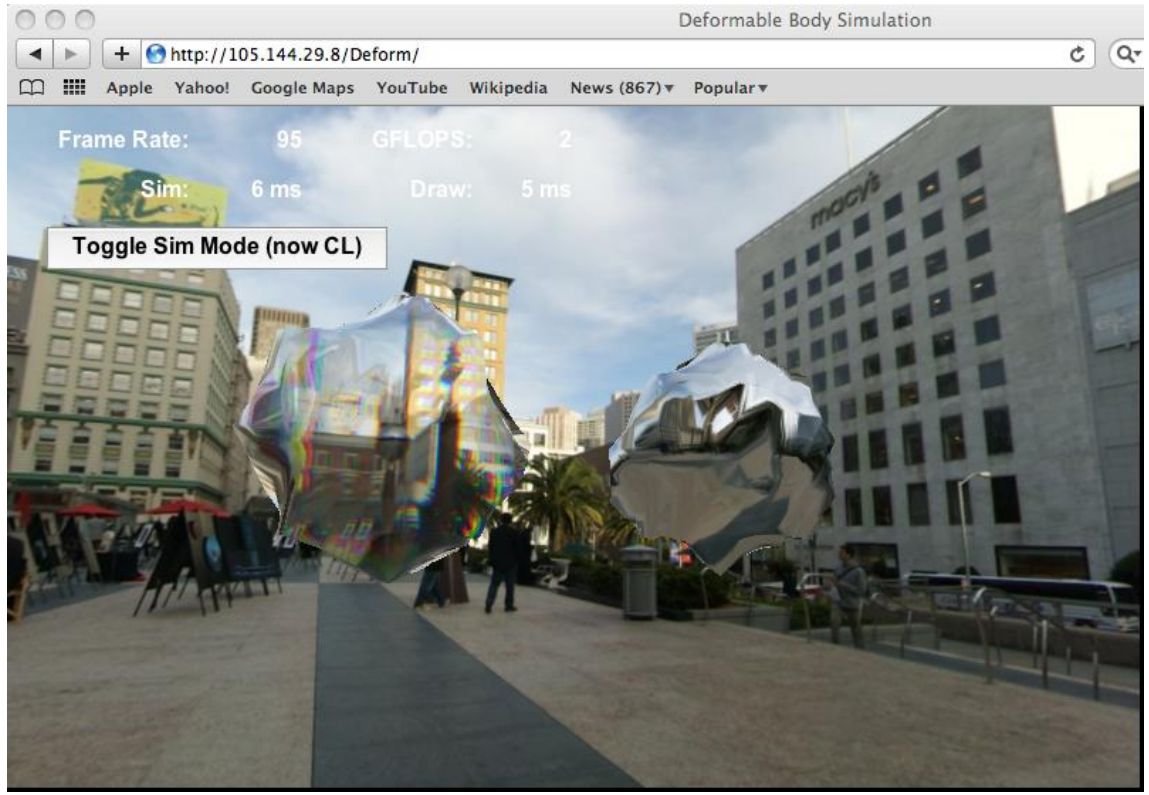




Samsung WebCL Prototype Demo

Deformation Demo:

- Calculates and renders transparent and reflective deformed spheres on top of photo background
- Performance comparison on Mac
  - JS: ~1 FPS
  - WebCL: 87-116 FPS
- http://www.youtube.com/user/SamsungSISA#p/a/u/1/9Ttux1A-Nuc



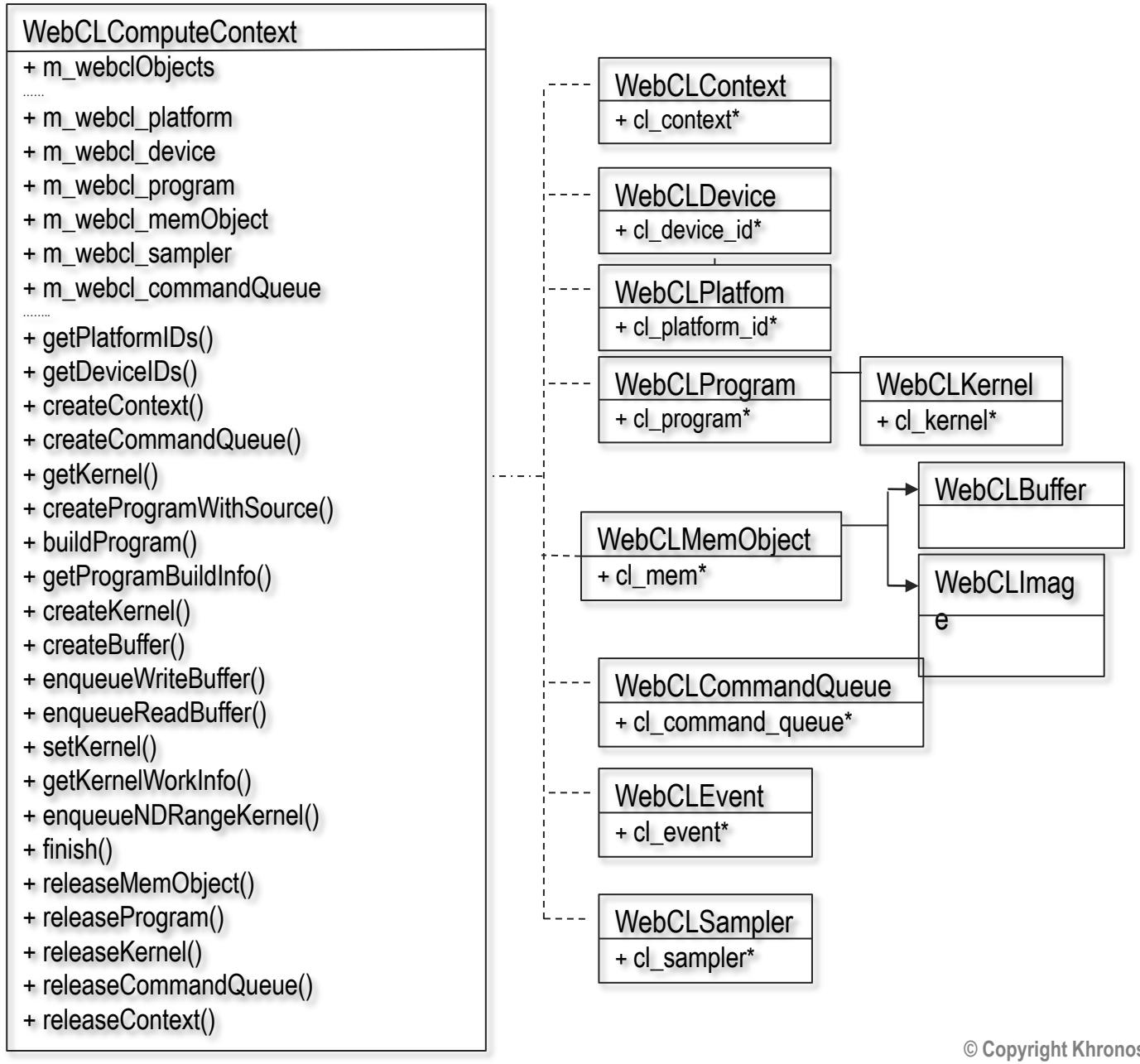
WebCL Resources

- **WebCL public distribution list:** webcl_public@khronos.org
- **WebCL public Wiki:** https://www.khronos.org/webcl/wiki/Main_Page
- **Nokia's WebCL prototype resources:**
  - Source code and tutorial (http://webcl.nokiaresearch.com/)
  - Demo on YouTube (http://www.youtube.com/watch?v=9BF7zzUM1kY)
- **Samsung's WebCL prototype resources:**
  - Demos on YouTube: (http://www.youtube.com/user/SamsungSISA
  - Code available on Google Docs (http://code.google.com/p/webcl/)
- **Call for participation in Khronos WebCL Working Group.**

For further information on WebCL, contact:
WebCL Chair: Tasneem Brutch (t.brutch@samsung.com)
WebCL Editor: Tomi Aarnio (tomi.aarnio@nokia.com)

Backup

WebCL Class Hierarchy



Samsung WebCL Prototype Interface

(Sample Calls from HelloWorld App for Illustration-1/3)

```
<html>
<head>
<title>WebCL Hello World</title>

<script>
function getKernel (id ) {
   var kernelScript = document.getElementById( id );
}
</script>
<script id="square" type="x-kernel">
   __kernel void square(
      __global float* input,
      __global float* output)
   {
      int i = get_global_id(0);
      output[i] = input[i] * input[i];
   }
</script>

<script>
var cl;
var platform_ids, device_ids;
var context, queue, program, kernel, input, output;
var err;
var data = new Float32Array(DATA_SIZE);
var results = new Float32Array(DATA_SIZE);
```

Samsung WebCL Prototype Interface

(Sample Calls from HelloWorld App for Illustration-2/3)

```
function ExecuteCL( )  {
   cl = new WebCLComputeContext ( );
   platform_ids = cl.getPlatformIDs ( );
   device_ids = cl.getDeviceIDs (platform_ids[0], cl.DEVICE_TYPE_GPU );

   context = cl.createContext (null, device_ids[0], null, null);

   queue = cl.createCommandQueue (context, device_ids[0], null);

   var kernelSource = getKernel ("square");

   program = cl.createProgramWithSource (context, kernelSource);

   err = cl.buildProgram (program, null, null, null);
   var info = cl.getProgramBuildInfo (program, device_ids[0],
                                      cl.PROGRAM_BUILD_LOG);
   kernel = cl.createKernel (program, "square");

   input = cl.createBuffer (context, cl.MEM_READ_ONLY,
           Float32Array.BYTES_PER_ELEMENT * count, null);
   output = cl.createBuffer (context, cl.MEM_WRITE_ONLY,
            Float32Array.BYTES_PER_ELEMENT * count, null);
```

Samsung WebCL Prototype Interface

(Sample Calls from HelloWorld App for Illustration-3/3)

```
    cl.enqueueWriteBuffer (queue, input, true, 0,
                           Float32Array.BYTES_PER_ELEMENT * count, data, null);
    err = cl.setKernelArgGlobal (kernel, 0, input);
    err = cl.setKernelArgGlobal (kernel, 1, output);

    var local = cl.getKernelWorkGroupInfo (kernel, device_id,
                         cl.KERNEL_WORK_GROUP_SIZE);

    cl.enqueueNDRangeKernel (queue, kernel, 1, 0, count, local, null);

    cl.finish (queue, null, function(userData) {
        cl.enqueueReadBuffer (queue, output, true, 0,
                        Float32Array.BYTES_PER_ELEMENT * count, results, null);
        cl.releaseMemObject     (input);
        cl.releaseMemObject     (output);
        cl.releaseProgram       (program);
        cl.releaseKernel        (kernel);
        cl.releaseCommandQueue  (queue);
        cl.releaseContext       (context);
    });
}
</script>
</head>
```