Native CPU Performance in the Browser with Google Native Client

http://code.google.com/p/nativeclient

Brad Chen
Engineering Manager
Google Native Client
Why Native Code?

Close the gap between desktop and web apps...

- Performance
- Choice of programming language
- Leverage legacy code

... but do not sacrifice

- Portability
- Safety
What we mean by “Performance”

Key performance features include

• POSIX-like thread support
• Straightforward access to vector instructions
• Hand-coded assembler

Substantially all the CPU performance of desktop applications
Scenario: An AJAX application
• generates a large HTML table on the client
• computes a floating-point intensive result

How does JavaScript perform compared to C?
C and JavaScript Performance. C times include delivering data into browser. *N.B.*: Obvious C++ implementation is 2x slower than JavaScript.
What does it mean for the Web?

Desktop CPU performance will enable Web apps with:

- Safer multimedia codecs
- Real-time audio and video synthesis
- Real-time physics simulations
- Local audio/video analysis and recognition
- Multimedia editors
- Flexible, high-throughput cryptography
- Application-specific data compression
- ...

Together with O3D we will enable:

- High quality games
- CAD applications
- ...

The Life of a NaCl-Enabled Web App
The Life of a NaCl-Enabled Web App

A Global Cooling Game

Image Credit: NASA/Goddard Space Flight Center Image by Reto Stockli (land surface, shallow water, clouds)
Enhancements by Robert Simon (ocean color, compositing, 3D globe, animation). Data and technical support MODIS Land Group, MODIS Science Data, Support Team, MODIS Atmosphere Group, MODIS Ocean Group Additional data: USGS EROS Data Center (topography), USGS Terrestrial Remote Sensing Flagstaff Field Center (Antarctica), Defense Meteorological Satellite Program (Satellite).
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```html
<html>
...<object src="game.nexe">
```
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Native Client Helper
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The Life of a NaCl-Enabled Web App
Native Client Security
Native Client Security

Our goal: make native code at least as safe as JavaScript.

Steps we’ve taken include:

• Multiple internal security reviews
• Open sourced our system; encouraged critical public review
• Published a peer reviewed technical paper in the *IEEE 2009 Symposium on Security and Privacy*
• Held a security contest
Native Client Security Contest

• 25 February to 5 May 2009
• Over 400 teams and 600 individuals participated
• 22 valid issues submitted

Profile of valid issues:
  – Inner sandbox (1 + 1 prior to contest)
  – Outer sandbox (not yet enabled)
  – Binary module loader
  – Trampoline interfaces (1 – direction flag)
  – IMC communications interface
  – NPAPI interface (3 – including same origin issues)
  – System calls (1 – unmap / map)
  – Browser integration (8)
NaCl Today and Tomorrow
Native Client Research Release

Today

• NPAPI plugin
• x86-32 only
• Raster graphics
• Mirrored public SVN
Native Client Developer Release…

Today
• NPAPI plugin
• x86-32 only
• Raster graphics
• Public SVN

The Future
• **Built into browser**
  • Web Workers
  • Revised NPAPI
• **x86-32, x86-64, ARM**
• **O3D integration**
An H.264 Video Player
Porting a H.264 transcoder from Linux

- Based on a Google internal H.264 decoder
- Original test code decoded H.264 into raw frames
- 20-line change to create simple video player
- 230-lines to add audio and frame-rate control

Porting a Linux application to Native Client can be very simple.
```c
int main(int argc, char *argv[]) {
    ...
    #ifdef __native_client__
        int r = nacl_multimedia_init(NACL_SUBSYSTEM_VIDEO);
        if (-1 == r) {
            printf("Multimedia system failed to initialize!  errno: %d\n", errno);
            exit(-1);
        }
        r = nacl_video_init(NACL_VIDEO_FORMAT_RGB, image_width, image_height);
        if (-1 == r) {
            printf("Video subsystem failed to initialize!  errno; %d\n", errno);
            exit(-1);
        }
        write_file_ptr = NULL;
    #else
        write_file_ptr = fopen("output.yuv", "wb");
    #endif
    ...
```
#ifndef __native_client__
    YV12toRGB24_generic(img->luma_sample, img->luma_width,
                       img->chroma_sample[0], img->chroma_sample[1],
                       img->chroma_width, RGB24_out,
                       img->luma_width, img->luma_height,
                       img->luma_width);

    r = nacl_video_update(RGB24_out);
    if (-1 == r) {
        printf("nacl_video_update() returned %d\n", errno);
    }
#else
    fwrite(img->luma_sample,      frame_size,    1, write_file_ptr);
    fwrite(img->chroma_sample[0], frame_size>>2, 1, write_file_ptr);
    fwrite(img->chroma_sample[1], frame_size>>2, 1, write_file_ptr);
#endif
...
Demo: H.264 Video Decoder
Demo: Native Client Darkroom
Questions?

On the web: http://code.google.com/p/nativeclient

Related projects:
Chromium: http://dev.chromium.org
O3D: http://code.google.com/p/o3d
Contribute

Please visit us at http://code.google.com/p/nativeclient

- Write new apps
- Port existing C/C++ libraries
- Help us test
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Web Workers: Simple threading model for the browser

- No shared data, no DOM access
- postMessage, XMLHttpRequest, openDatabase
- See specification at http://whatwg.org/ww

Goals of Native Web Workers:

- Support workers in C, C++, Ruby, ...
- Maintain the simplicity of the Web Worker model
- Support 'low frequency' applications
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