



Google

Developers



Introduction to Portable Native Client (PNaCl)

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Tech lead, Native Client





Background

C++ Code, the Web, and Native Client

Background

```
[chrome] Contents of /trun x  
src.chromium.org/viewvc/chrome/trunk/src/base/bind.h  
80  
81 template <typename Functor, typename P1>  
82 base::Callback<  
83     typename internal::BindState<  
84         typename internal::FunctorTraits<Functor>::RunnableType,  
85         typename internal::FunctorTraits<Functor>::RunType,  
86         void(typename internal::CallbackParamTraits<P1>::StorageType)>  
87         ::UnboundRunType>  
88 Bind(Functor functor, const P1& p1) {  
89     // Typedefs for how to store and run the functor.  
90     typedef typename internal::FunctorTraits<Functor>::RunnableType RunnableType;  
91     typedef typename internal::FunctorTraits<Functor>::RunType RunType;  
92  
93     // Use RunnableType::RunType instead of RunType above because our  
94     // checks should below for bound references need to know what the actual  
95     // functor is going to interpret the argument as.  
96     typedef internal::FunctorTraits<typename RunnableType::RunType>
```



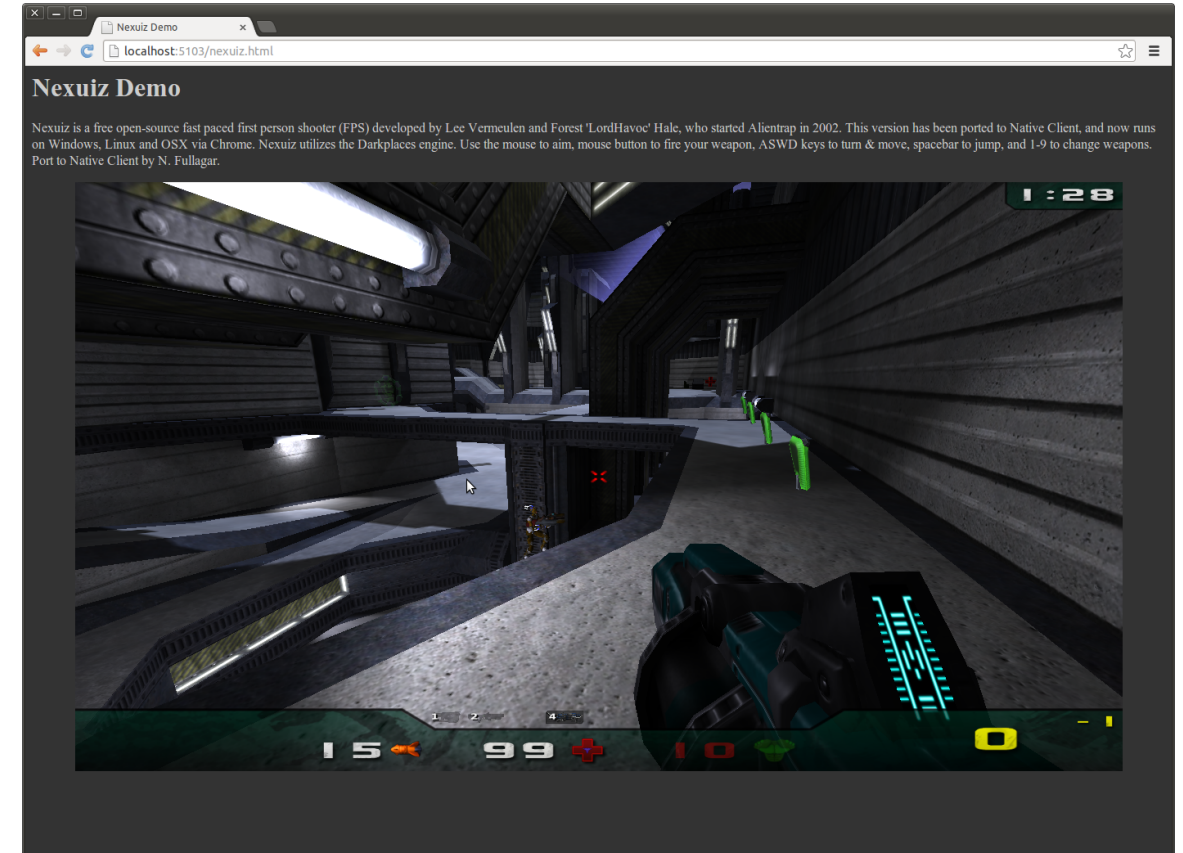
<http://security.arizona.edu/sites/default/files/id%20theft.jpg>



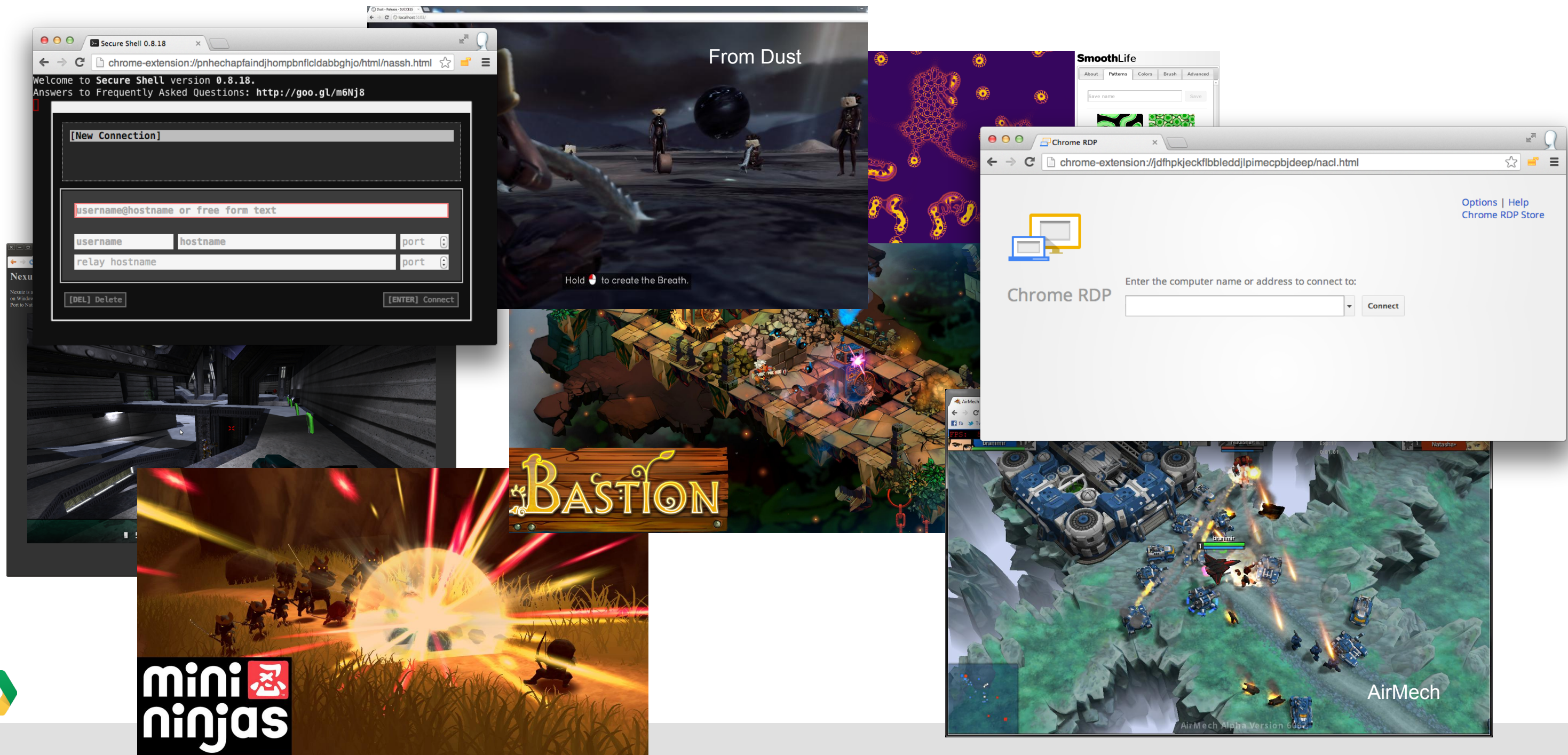
<http://www.nw-cpa.com/wp-content/uploads/2013/03/man-in-prison-behind-bars-jail.jpg>



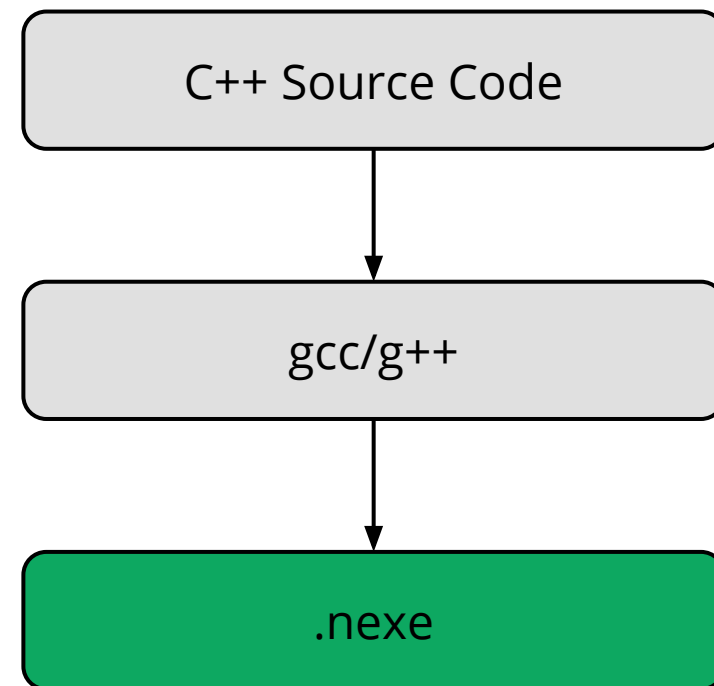
Native Client



A Few Native Client Applications



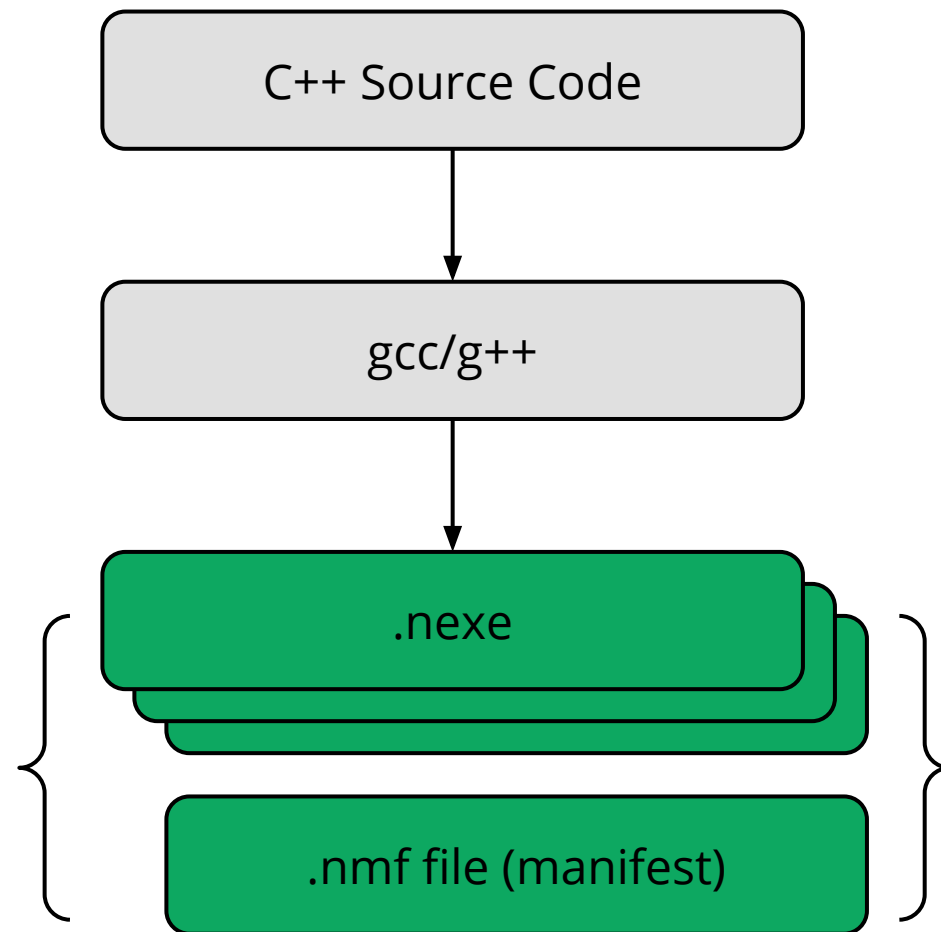
Building a Native Client Application



- Native executable
- Portable across operating systems
- Specific to x86, ARM, etc.



Building a Native Client Application



```
<embed name="nacl_module"
  id="air_mech"
  src="air_mech.nmf"
  type="application/x-nacl" />
```

HTML



Instruction Set Architecture (ISA) Dependency

NaCl Manifest File

.nmf

```
{  
  "files": {},  
  "program": {  
    "x86-64": { "url": "air_mech_x86_64.nexe" },  
    "x86-32": { "url": "air_mech_x86_32.nexe" },  
    "arm": { "url": "air_mech_arm.nexe" }  
  }  
}
```

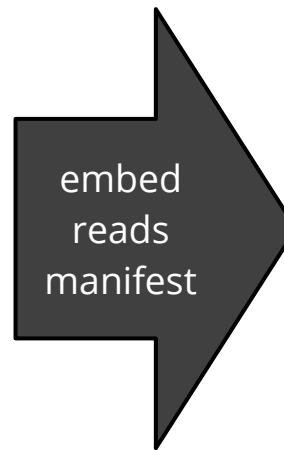
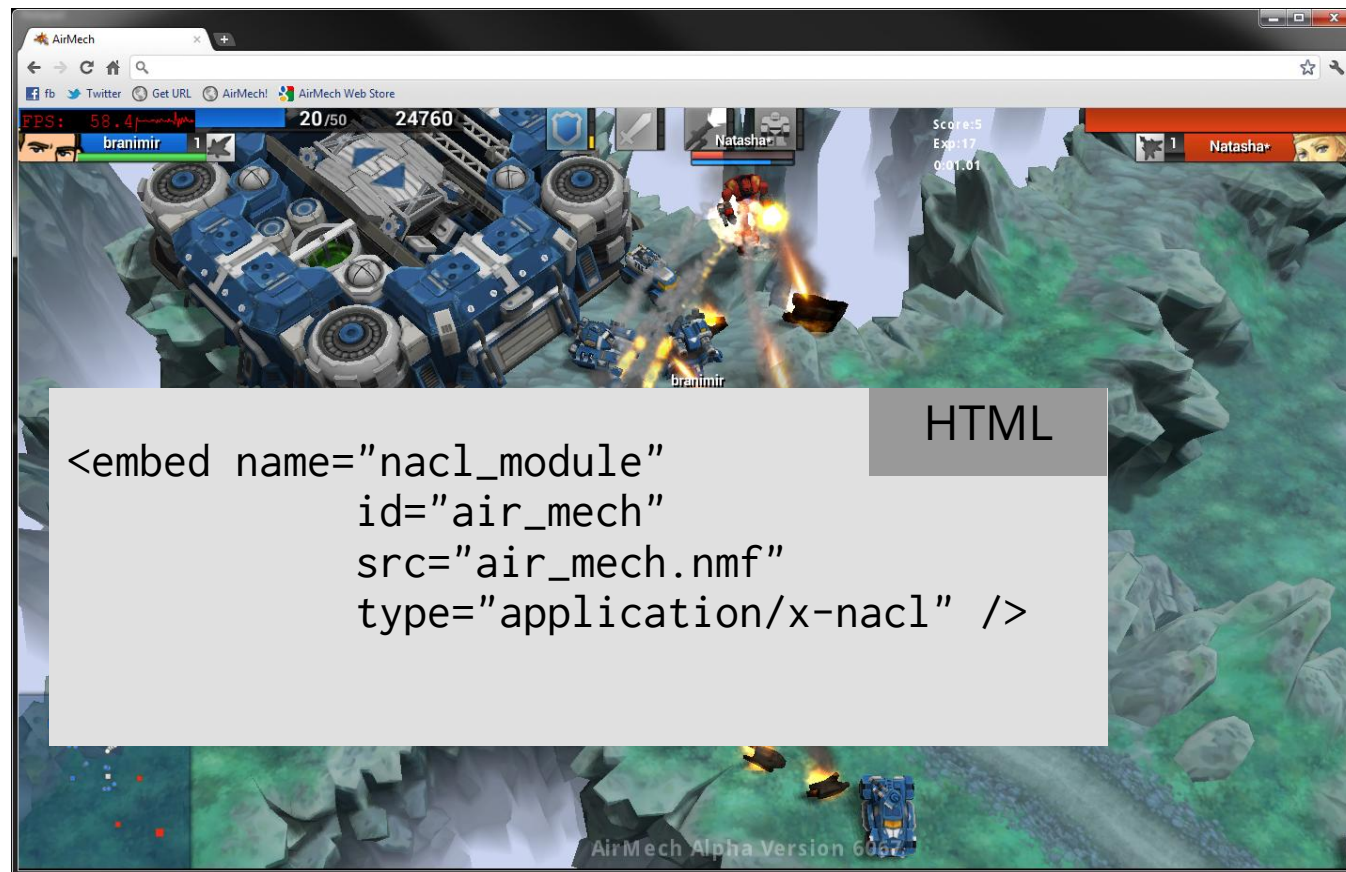
Which ISA

Where to find its executable

Every supported ISA needs an entry here



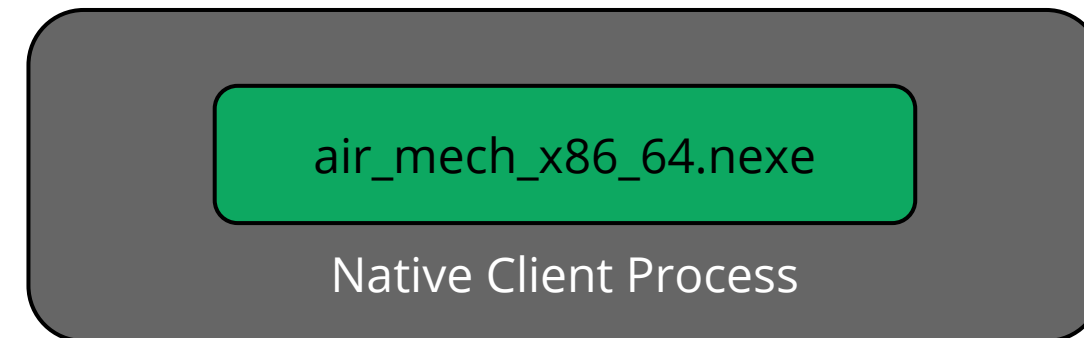
Running a Native Client Application



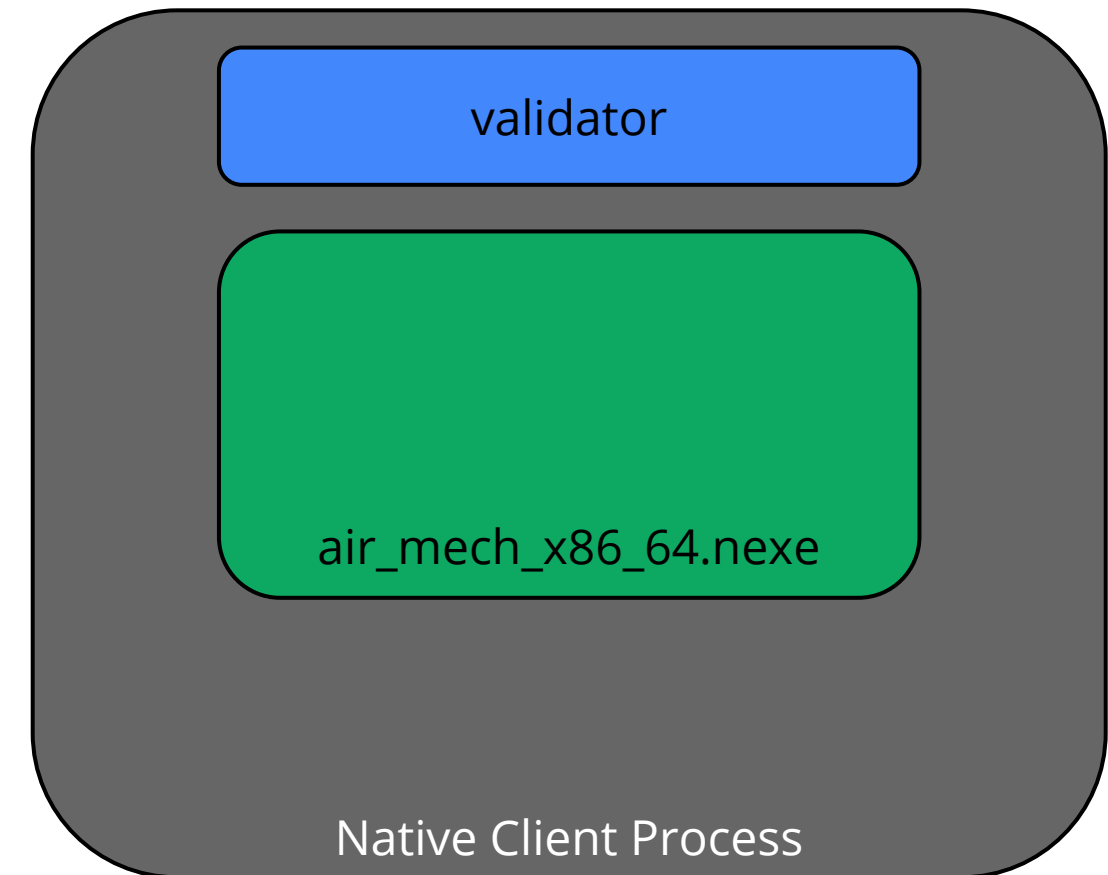
air_mech.nmf

```
{
  "files": {},
  "program": {
    "x86-64": { "url": "air_mech_x86_64.nexe" },
    "x86-32": { "url": "air_mech_x86_32.nexe" },
    "arm": { "url": "air_mech_arm.nexe" }
  }
}
```

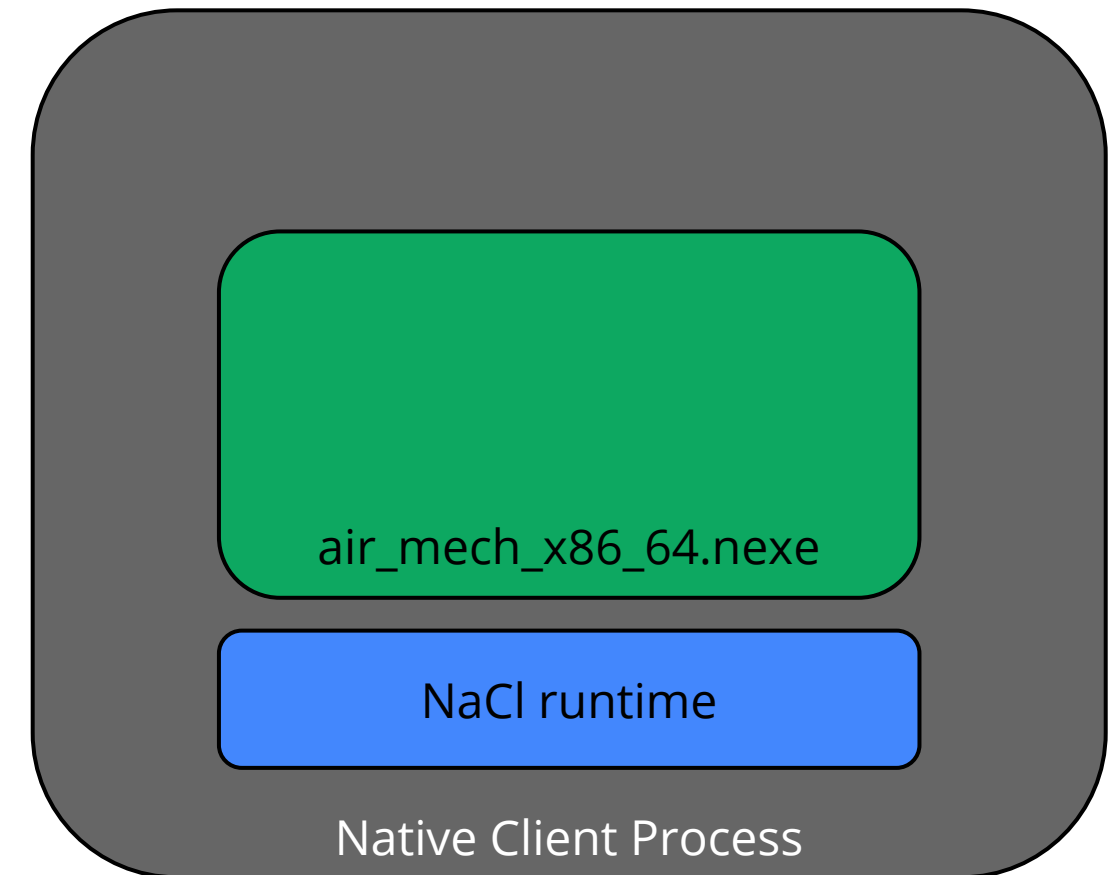
.nmf



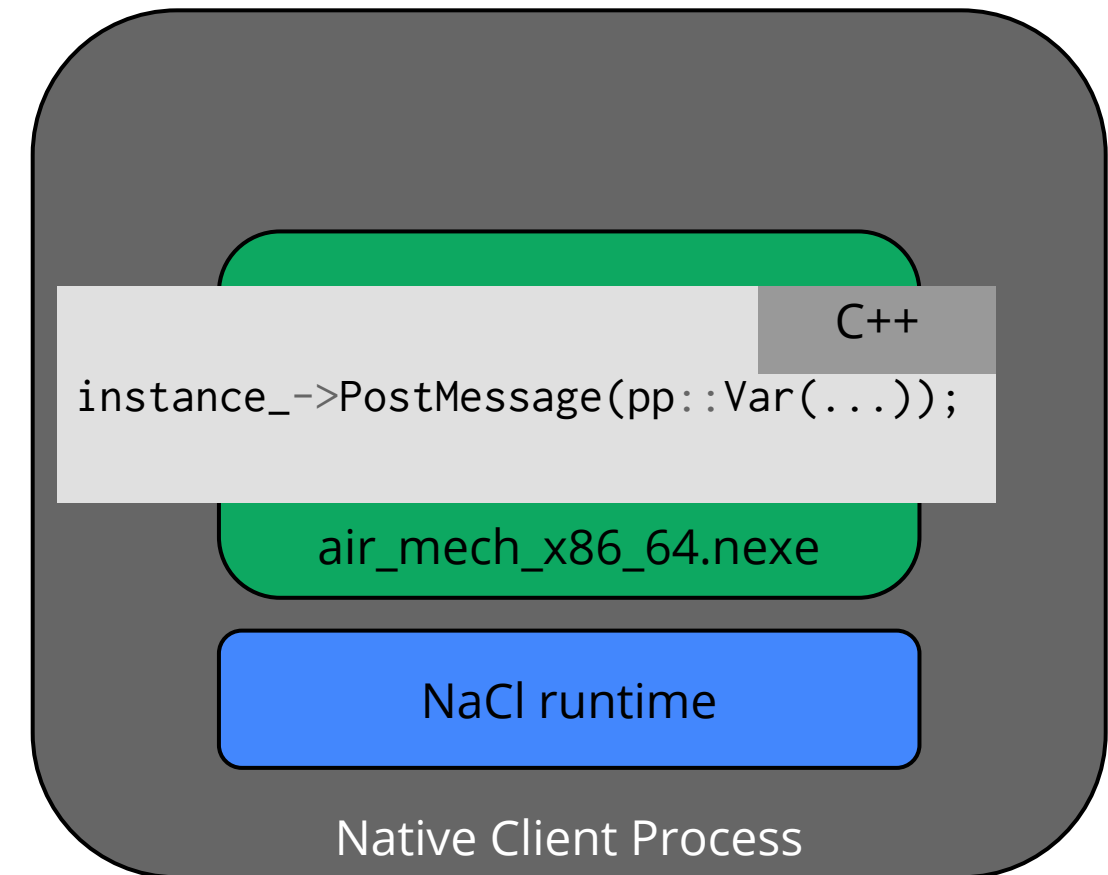
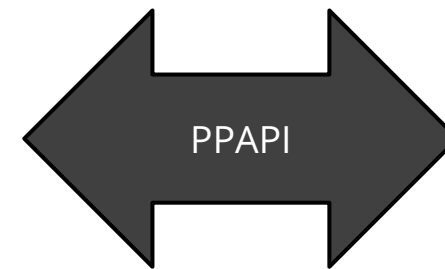
Running a Native Client Application



Running a Native Client Application



Running a Native Client Application

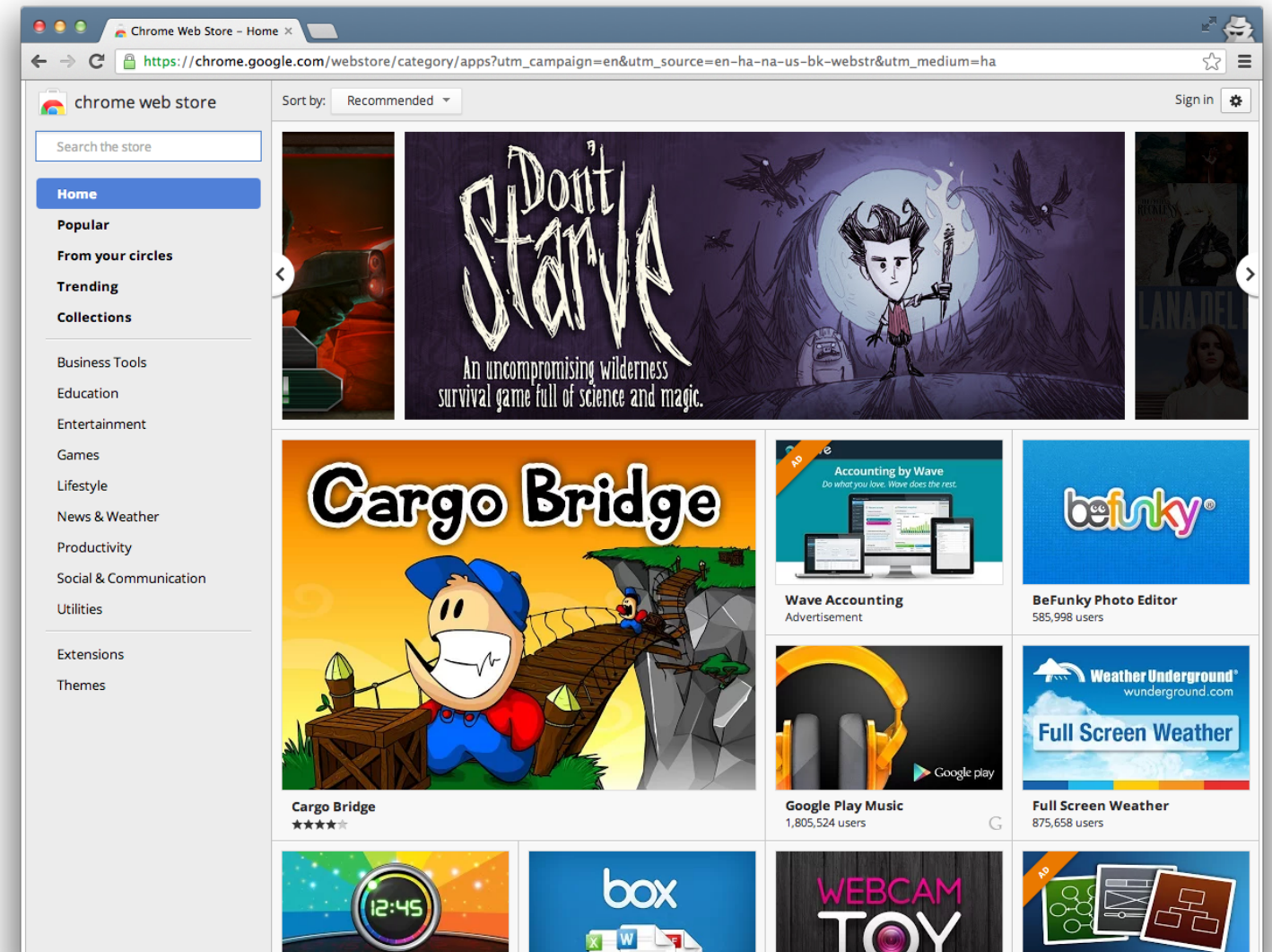


.nexes are Out-of-Process Plugins



Native Client Limitations

"No ISAs in the web platform"



So We're Done, Right?

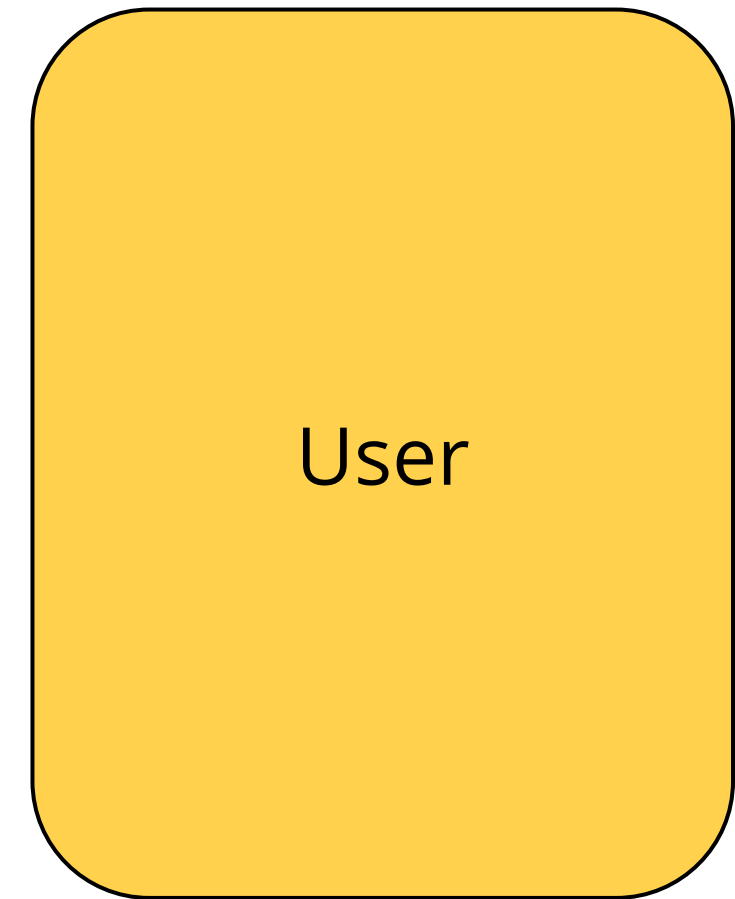
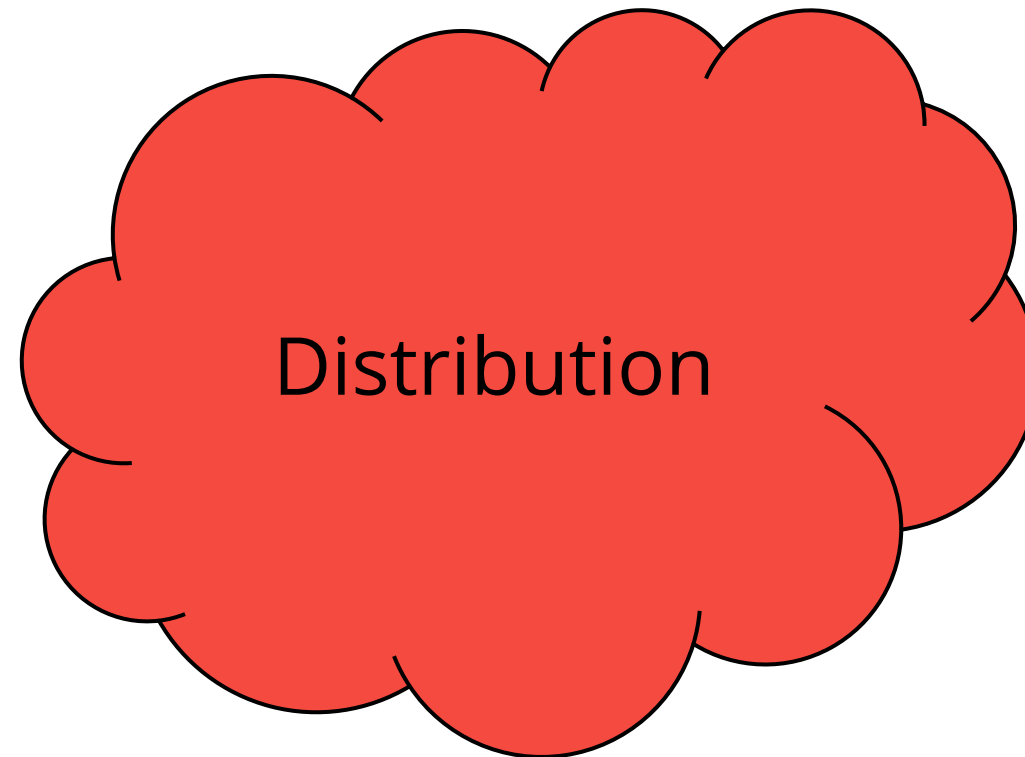
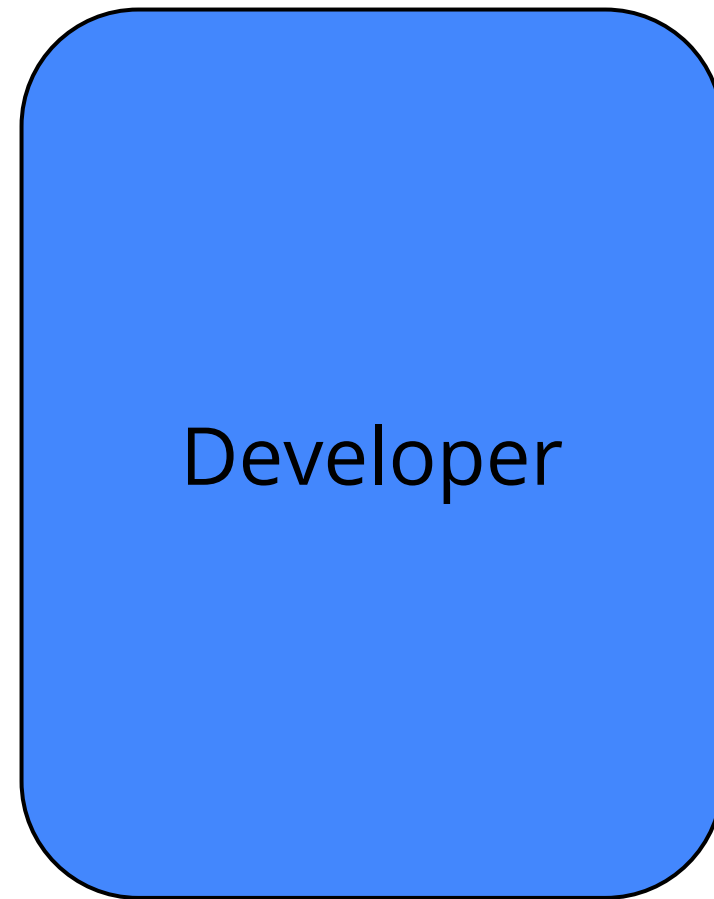
- C++ executables
- Run in the browser
- Distributed in the web store
- Native ISA code is not right for the open web
- We need a way to upload device-independent code, then translate to the client's ISA...





Portable Native Client

Portable Native Client

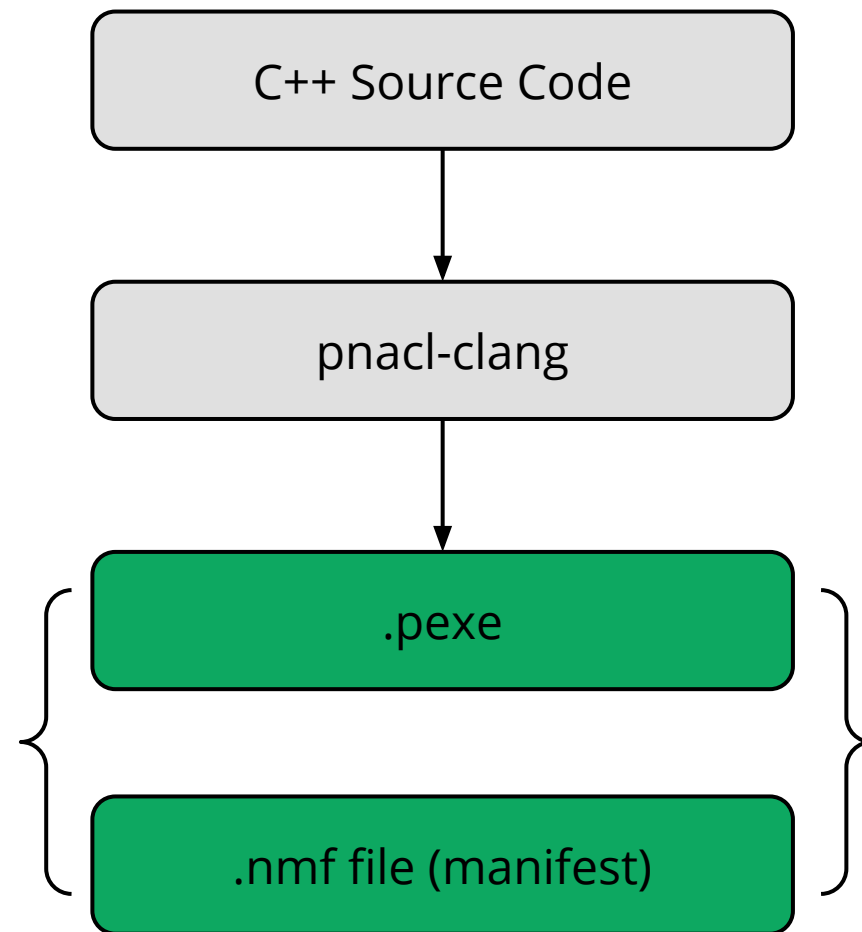


Portable Native Client

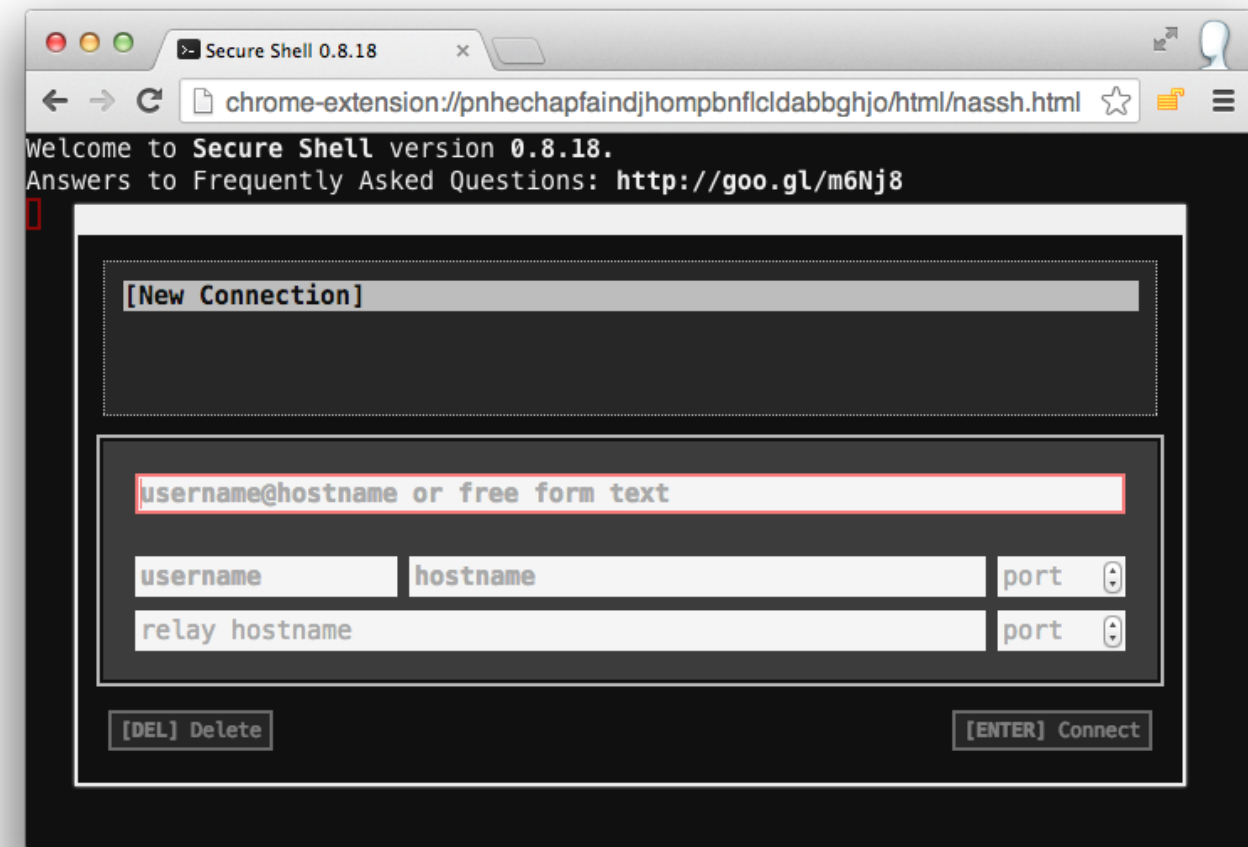
- C/C++
 - ILP32 (`sizeof(int) == sizeof(long) == sizeof(void*) == 4`)
 - Little endian
 - IEEE fp
- One executable runs on
 - Windows, OS X, Linux, ChromeOS
 - x86-32, x86-64, ARM, ...



Developing a Portable Native Client Application



=



+

```
HTML
<embed name="nacl_module"
  id="ssh"
  src="ssh.nmf"
  type="application/x-nacl" />
```



Manifest for a PNaCl Application

Just One Portable Executable

```
{  
  "files": {},  
  "program": {  
    "portable": {  
      "pnacl-translate": {  
        "url": "ssh.pexe",  
        "-0": "2"  
      }  
    }  
  }  
}
```

.nmf

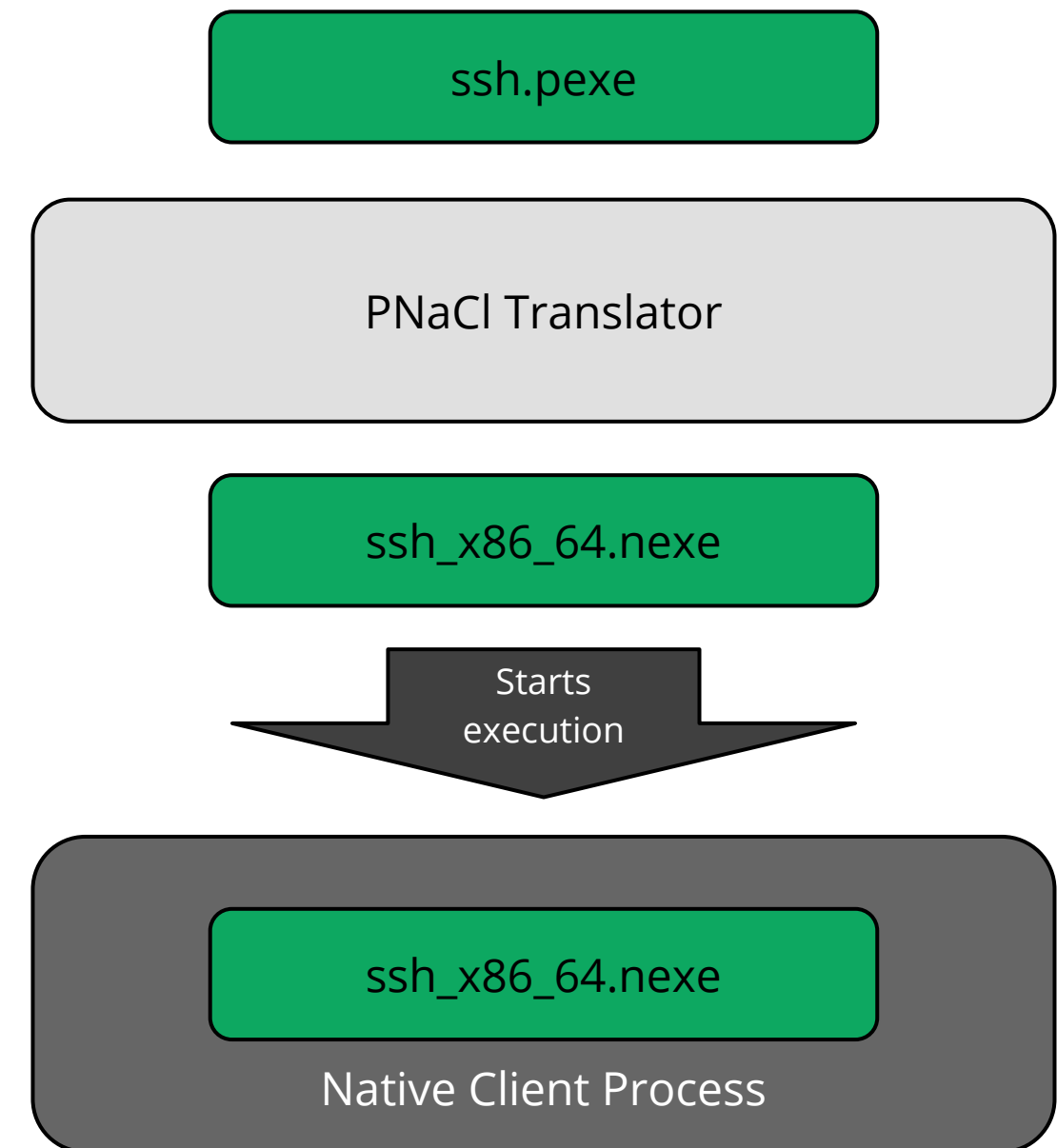
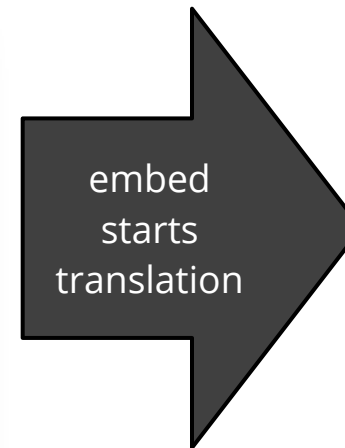
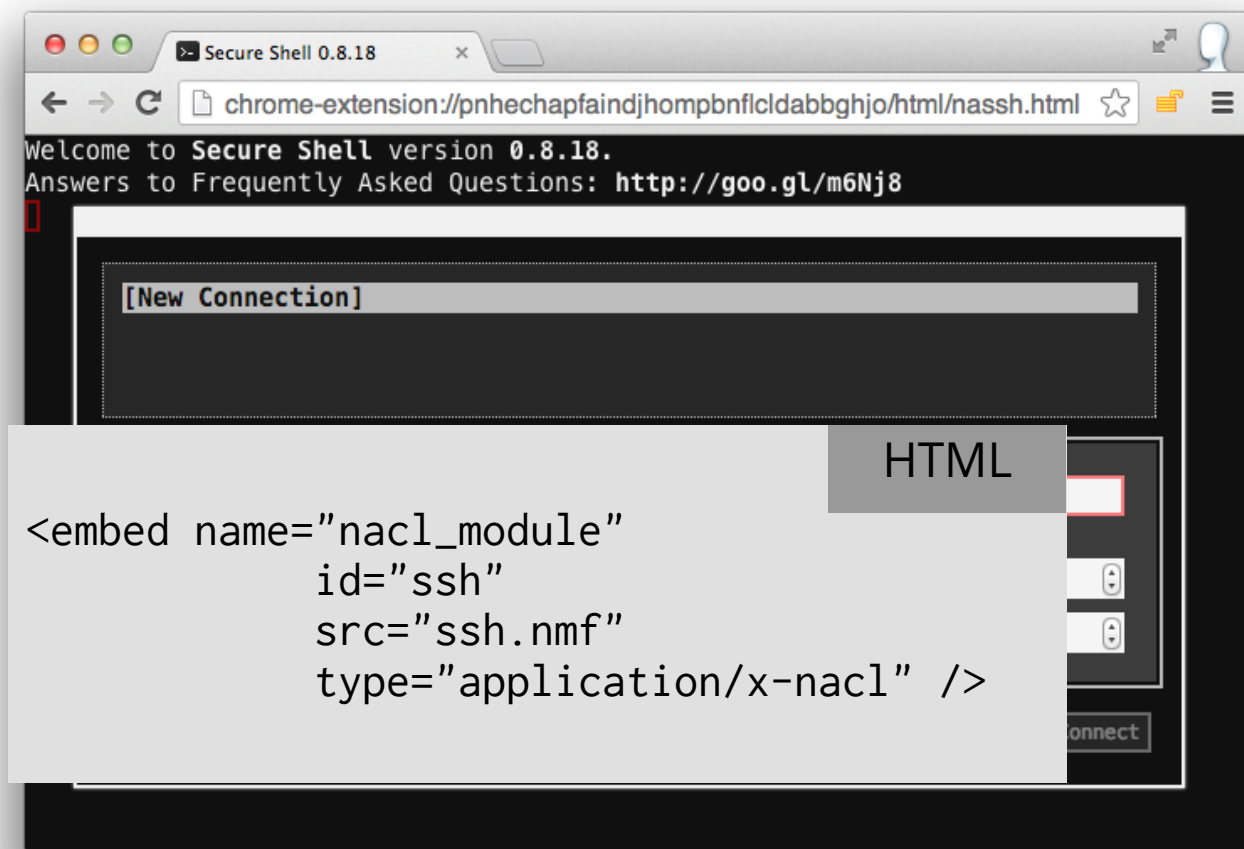
One "portable" rather than one entry per ISA

Where to find the portable executable

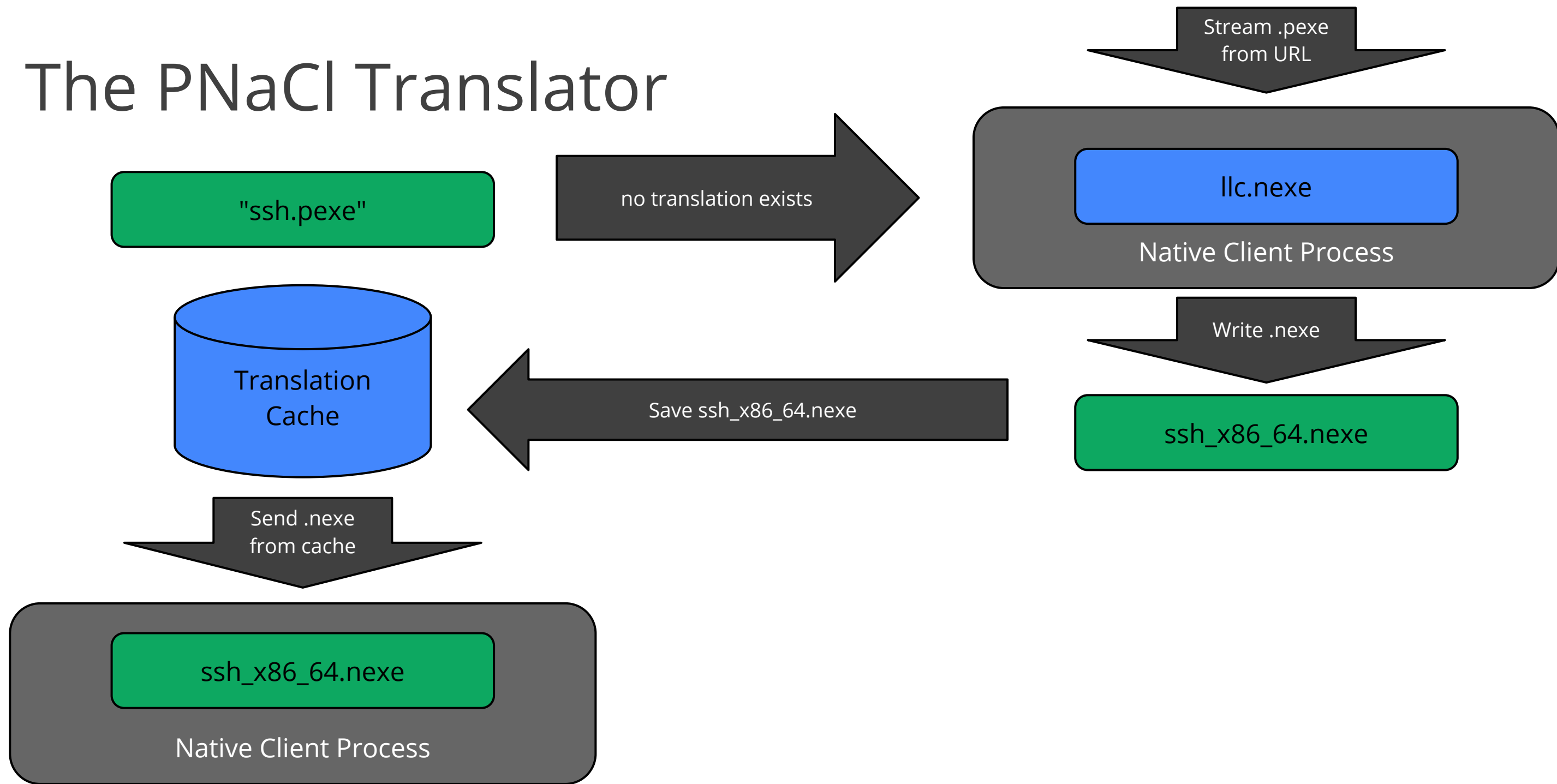
Translated code performance requested



Running a PNaCl Application



The PNaCl Translator

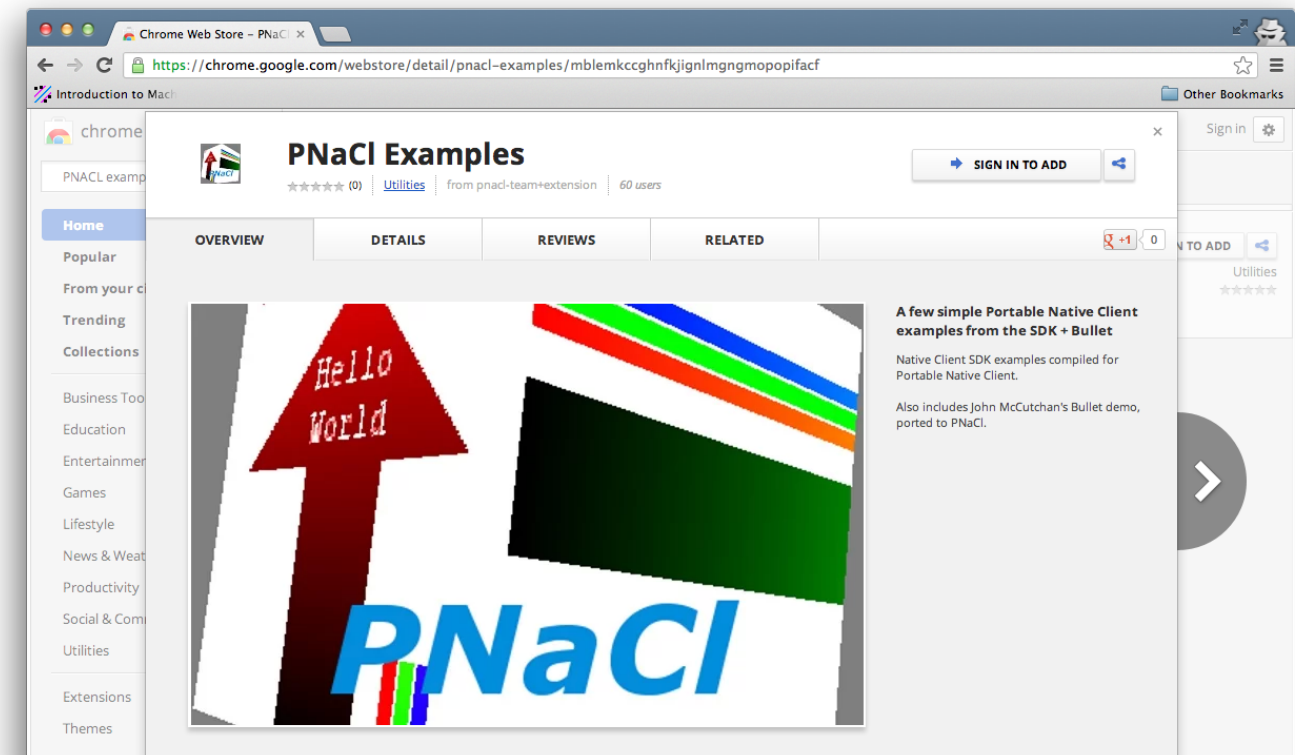
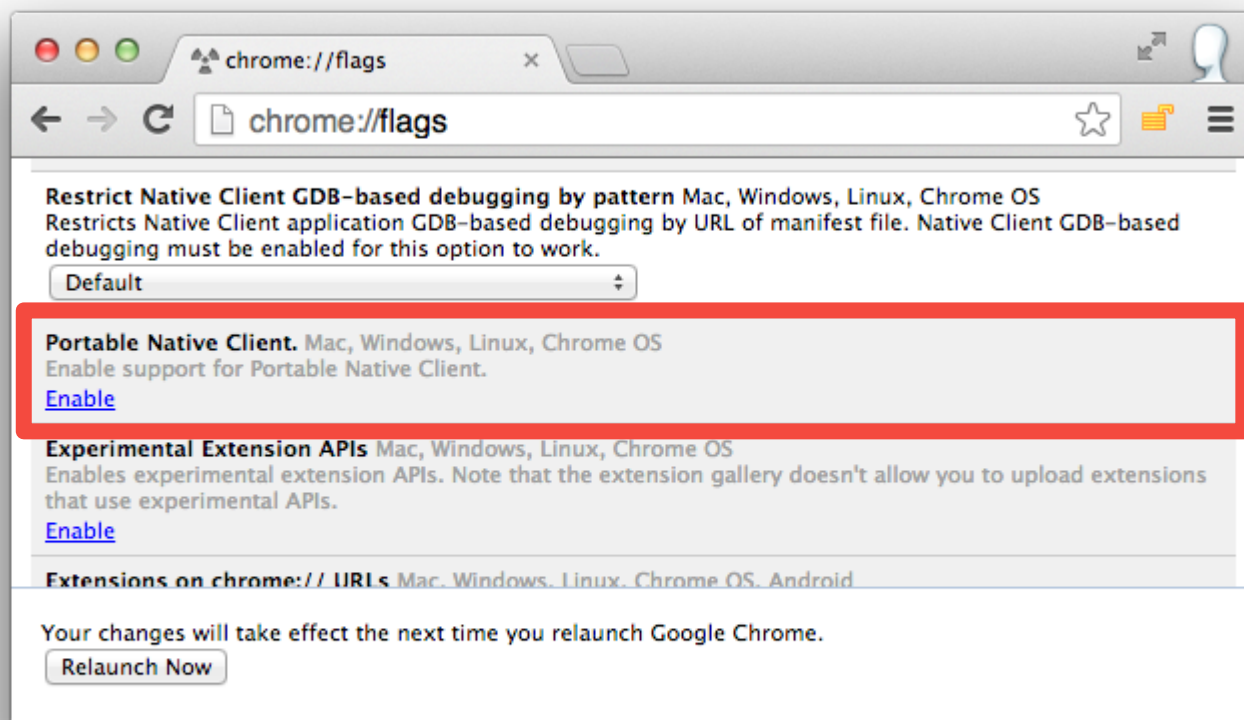




How Do I Use It?

Developer Preview in Chrome

- In Chrome 29 (canary, dev channel)
- Enable the flag
- Try the *PNaCl Examples* extension



**We want your feedback
at <http://gonacl.com>**



PNaCl SDK

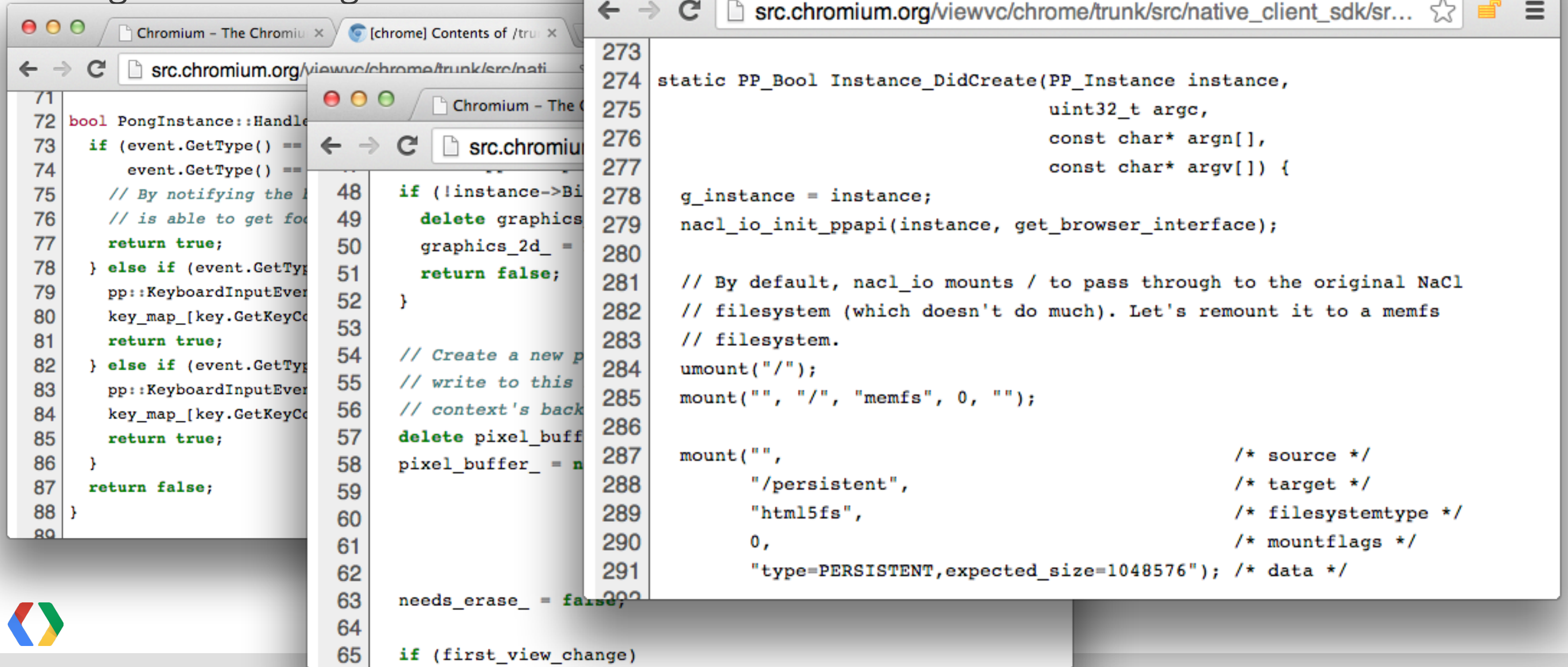
- Compiler, debugger, libraries
- NaClPorts
- Examples, demos



The screenshot shows the Google Developers page for Native Client. The browser address bar displays <https://developers.google.com/native-client/>. The page features a navigation menu with links for Home, Products, Conferences, Showcase, Live, and Groups. A search bar is present with the text "Native Client X" and a search icon. The user profile "david.sehr@gmail.com" is visible in the top right corner. The main content area includes a "Native Client" header with a +1 button and "1.5k" likes. A sidebar on the left lists navigation options: "Version 26 (stable)", "News & Announcements", "Technical Overview", "Quick-start", "SDK", "Developer's Guide", "Pepper C API", "Pepper C++ API", "Community", "FAQ", and "Get Help with NaCl". The main content area features a large banner with the text "Run your native code on the web." and "Native Client makes it possible." accompanied by a "GET STARTED" button. Below the banner are three informational boxes: "Documentation Version" (stating the current version is Chrome/Pepper 26 (stable)), "Coming Soon: PNaCl" (describing the benefits of Portable Native Client), and "Why use Native Client?" (directing users to the Technical Overview page).

PPAPI

Writing a Secure Plugin



```
71  
72 bool PongInstance::Handle  
73     if (event.GetType() ==  
74         event.GetType() ==  
75         // By notifying the  
76         // is able to get fo  
77         return true;  
78     } else if (event.GetTyp  
79     pp::KeyboardInputEver  
80     key_map_[key.GetKeyCo  
81     return true;  
82     } else if (event.GetTyp  
83     pp::KeyboardInputEver  
84     key_map_[key.GetKeyCo  
85     return true;  
86     }  
87     return false;  
88 }  
89
```

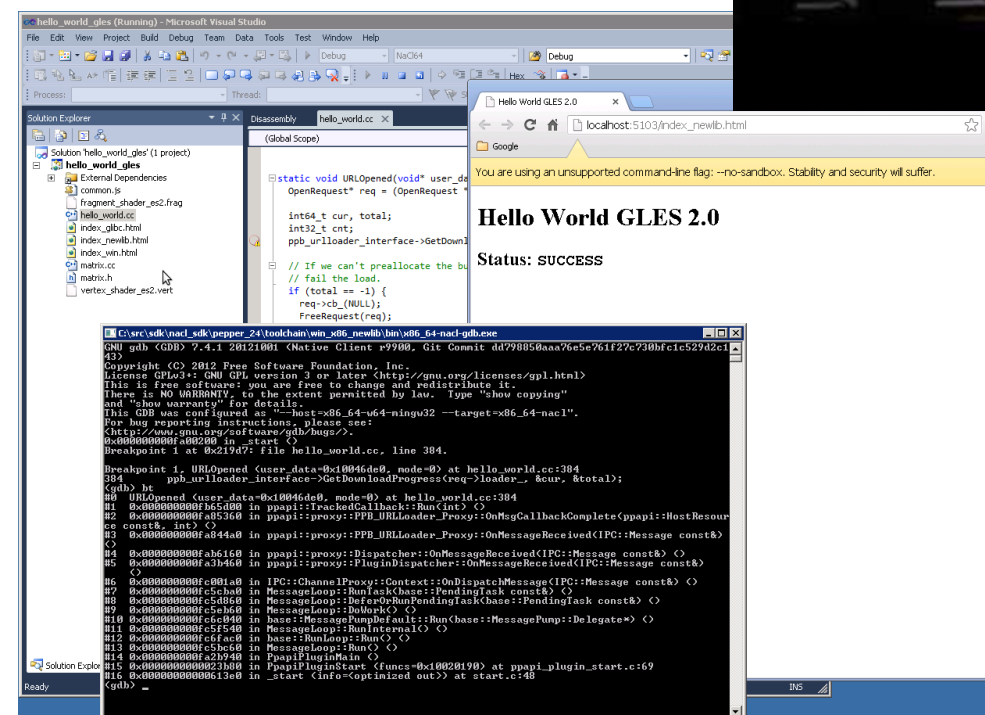
```
48     if (!instance->Bi  
49         delete graphics  
50         graphics_2d_ =  
51         return false;  
52     }  
53     // Create a new p  
54     // write to this  
55     // context's back  
56     delete pixel_buff  
57     pixel_buffer_ = n  
58  
59  
60  
61  
62  
63     needs_erase_ = false;  
64  
65     if (first_view_change)
```

```
273  
274 static PP_Bool Instance_DidCreate(PP_Instance instance,  
275                                     uint32_t argc,  
276                                     const char* argn[],  
277                                     const char* argv[]) {  
278     g_instance = instance;  
279     nacl_io_init_ppapi(instance, get_browser_interface);  
280  
281     // By default, nacl_io mounts / to pass through to the original NaCl  
282     // filesystem (which doesn't do much). Let's remount it to a memfs  
283     // filesystem.  
284     umount("/");  
285     mount("", "/", "memfs", 0, "");  
286  
287     mount("",                                     /* source */  
288           "/persistent",                          /* target */  
289           "html5fs",                               /* filesystemtype */  
290           0,                                       /* mountflags */  
291           "type=PERSISTENT,expected_size=1048576"); /* data */
```



Porting an Application to NaCl

1. Build as an out-of-process plugin
2. Convert browser interaction to PPAPI
 - a. 2D, audio, mouse/keyboard, files
 - b. Convert 3D graphics to OpenGL ES2.0
 - c. Convert Windows threads to pthreads
3. Convert to newlib and static linking



Porting an Application to PNaCl

1. Build as an out-of-process plugin
2. Convert browser interaction to PPAPI
 - a. 2D, audio, mouse/keyboard, files
 - b. Convert 3D graphics to OpenGL ES2.0
 - c. Convert Windows threads to pthreads
3. Convert to newlib and static linking
4. Remove assembly code



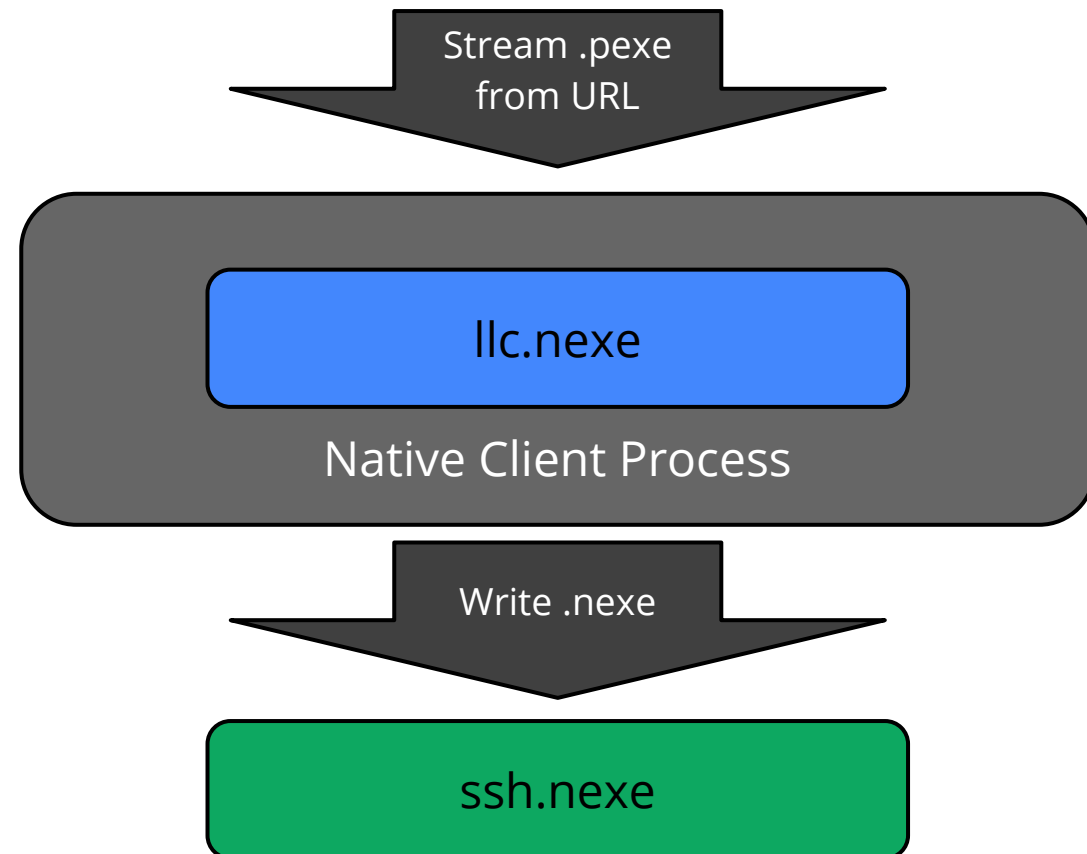
“40% of people abandon a website that takes more than 3 seconds to load”

Sean Work

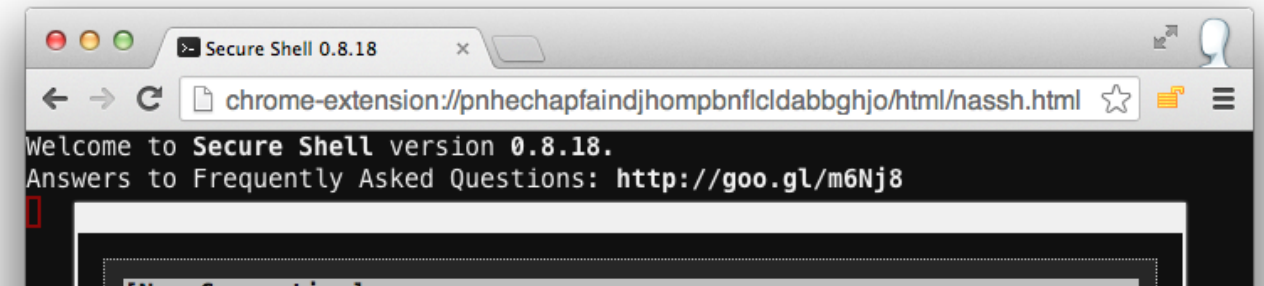
KISSmetrics



PNaCl Progress Events



"progress" events



```
function moduleLoadProgress(event) {
  var loadPercent = 0.0;
  var loadPercentString;

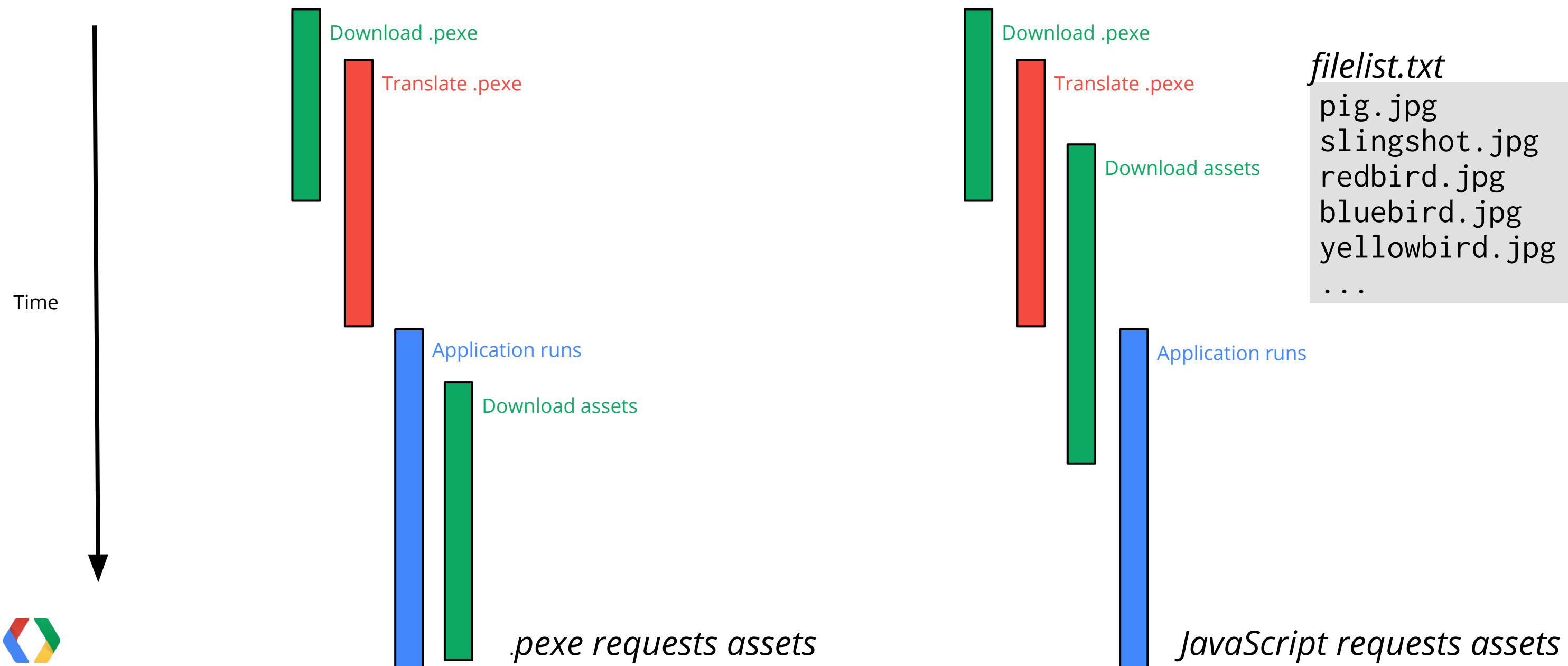
  if (event.lengthComputable && event.total > 0) {
    loadPercent = event.loaded / event.total * 100.0;
    loadPercentString = loadPercent + '%';
  } else {
    // The total length is not yet known.
    loadPercent = -1.0;
    loadPercentString = 'Computing...';
  }

  appendToEventLog('progress: ' + loadPercentString +
    '(' + event.loaded + ' of ' + event.total + ' bytes)');
}
```

JavaScript



Translation Time and Application Architecture



Translation Options for PNaCl Applications

Translate Speed and Execution Speed

```
{  
  "files": {},  
  "program": {  
    "portable": {  
      "pnacl-translate": {  
        "url": "ssh.pexe",  
        "-0": level  
      }  
    }  
  }  
}
```

.nmf

level	translation time	perf vs. native
0	1x	~50%
2	~2-3x	~80+%



Translation Rate

	00
x86 (high-end)	~750 KB/s
ARM (Chromebook)	~130 KB/s



Translation Rate

	00	02
x86 (high-end)	~750 KB/s	~250 KB/s
ARM (Chromebook)	~130 KB/s	~70 KB/s

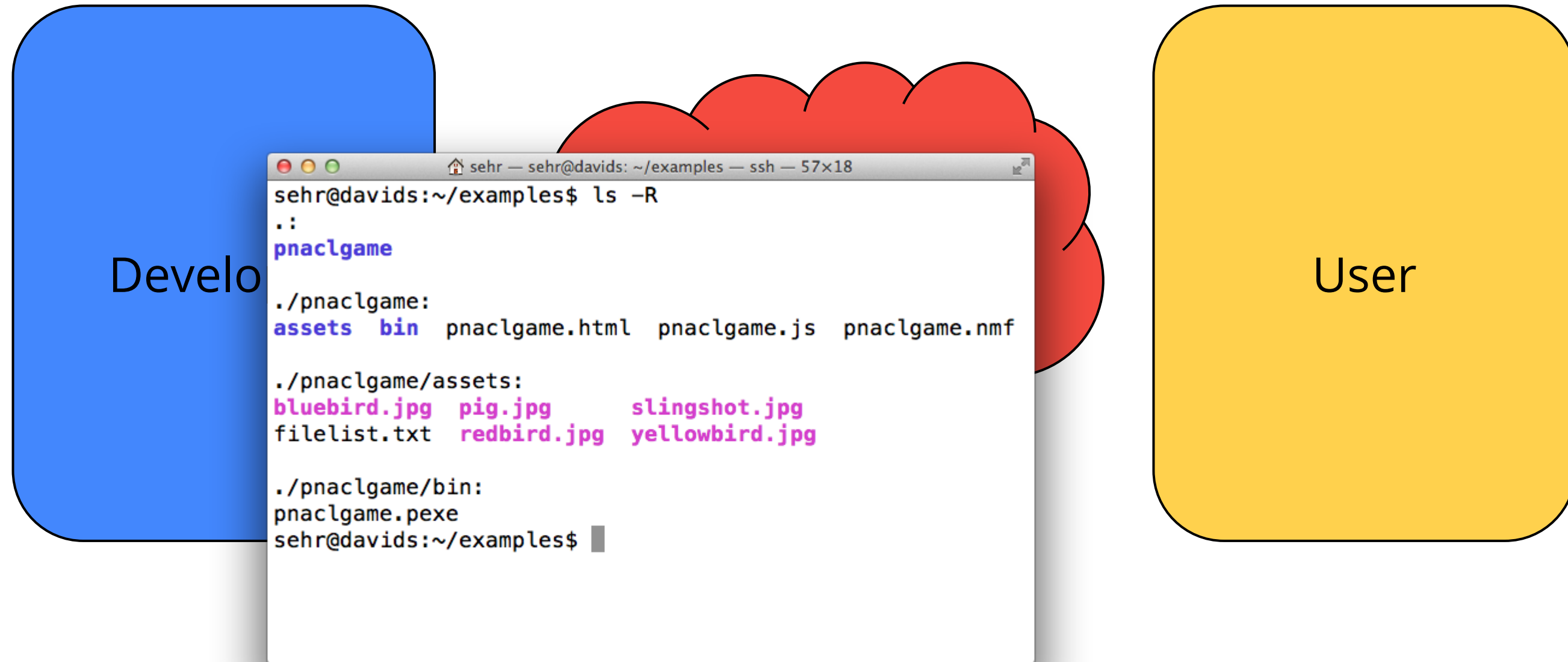


Performance

	O0 vs. native	O2 vs. native
Box2D	55%	85%
SPEC	45 - 50%	85 - 95%



Portable Native Client Distribution





A Taste of Things to Come

PNACL in Chrome

PNaCl Roadmap

Developer Features

	Launch
x86-32, x86-64, ARM	yes
pthread, atomics	yes
SIMD	no
C++ Exception Handling	no
Tools, Examples, Libraries, Debugger	yes
Dynamic Linking	no
JIT Support	no



PNaCl Roadmap

Developer Features

	Launch	First update
x86-32, x86-64, ARM	yes	
pthread, atomics	yes	
SIMD	no	yes
C++ Exception Handling	no	no
Tools, Examples, Libraries, Debugger	yes	
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PNaCl Roadmap

Developer Features

	Launch	First update	Second update
x86-32, x86-64, ARM	yes		
pthread, atomics	yes		
SIMD	no	yes	
C++ Exception Handling	no	no	yes
Tools, Examples, Libraries, Debugger	yes		
Dynamic Linking	no	no	???
JIT Support	no	no	???



PNaCl Roadmap

User Features

	Launch
Translation Cache	yes
Developer Choice of Optimization Level	yes
Streaming Translation	yes
Multicore Translation	no
Custom Fast Translator	no



PNaCl Roadmap

User Features

	Launch	First update
Translation Cache	yes	
Developer Choice of Optimization Level	yes	
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PNaCl Roadmap

User Features

	Launch	First update	Second update
Translation Cache	yes		
Developer Choice of Optimization Level	yes		
Streaming Translation	yes		
Multicore Translation	no	???	yes
Custom Fast Translator	no	no	???



Portable Native Client

- C++ code
- Run securely in the open web
- 80+% of native performance
- Try it right now in Chrome 29 canary (dev channel soon)
- We are targeting launch in Chrome 30



Thank You!

<http://gonacl.com>

sehr@google.com

native-client-discuss@googlegroups.com





Google

Developers