

V8 JavaScript Engine on Fedora 14

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The recent announcement by Google of a new compilation infrastructure, aptly codenamed [CrankShaft](#), for their V8 JavaScript engine prompted me to revisit this particular JavaScript engine and to compile and install it on a Fedora 14 X64 platform.

Crankshaft is the latest iteration of the [V8 JavaScript](#) (V8) engine and is somewhat similar to Mozilla's [TraceMonkey](#) JavaScript engine in that it attempts to aggressively optimize code that is regularly executed but avoid much optimization of code that is infrequently executed.

Currently the Mozilla [Spidermonkey](#) JavaScript shell is available as a standard RPM package for Fedora 14. In a previous [post](#) I showed how to build the Mozilla Tracemonkey JavaScript shell on Fedora 14. In this post I show how to build a V8 shell on Fedora 14.

Why build a V8 shell? Simply put, V8 is far faster than Tracemonkey. There are three key areas to it's superior performance:

- Fast Property Access
- Dynamic Machine Code Generation
- Efficient Garbage Collection

Read the V8 [Design Elements](#) web page for a detailed overview of these key areas.

V8 is written in C++ and makes extensive use of C++ namespaces. The V8 project is hosted at [Google Code](#). Use the following `svn` command to anonymously check out the latest up-to-date stable version of the V8 source code using `svn`:

```
$ svn checkout http://v8.googlecode.com/svn/trunk/ v8-read-only
```

V8 uses the popular opensource [SCons](#) software construction tool for building the various components of the project. If SCons is not installed on your platform (which it is not by default), it is available as a RPM from the Fedora standard repositories. SCons requires at least Python 2.4. If you have not used SCons before, you will be pleasantly surprised with it. A hidden gem!

Enter the following commands to build a V8 shell:

```
$ cd v8-read-only
$ scons
```

Add `arch=x64 d8` argument to `scons` if you are on an X64 platform. Add `mode=debug` if you want a debugging version of the shell. The shell that will be built is a developer's shell called `d8`.

While SCons will successfully build the `d8` shell, the shell hangs when you attempt to use it. The solution appears to be to change all the `gcc` compiler optimization switches from `-O3` to `-O2` in the `SConstruct` file. SConstruct is similar in purpose to a Makefile and is the input file that SCons reads to control the build.

```
'mode:release': {
```

```
'CCFLAGS':      ['-O2']
},
.....
'mode:release': {
  'CCFLAGS':      ['/O2'],
  ...
},
```

Change all the *mode:release* CCFLAGS to *O2*.

To clean the build system, invoke *scons* with the *-clean* option:

```
$ scons --clean
```

Another option available in the *d8* shell is support for command history and completions using the GNU [readline](#) library. To build the *d8* shell with command history support

```
$ scons arch=x64 console=readline d8
```

The current V8 shells do not support the *#!* ([shebang](#) AKA hashbang) interpreter directive functionality. The following modification to *./src/d8.cc* enables JavaScript scripts to be directly invoked using this functionality.

```
$ diff src/d8.cc.org src/d8.cc
699a700,737
>
> FILE* file = i::OS::FOpen(argv[1], "rb");
> if (file) {
>   int ch = fgetc(file);
>   int chl = fgetc(file);
>   if (ch == '#' && chl == '!') { // #! shebang
>     // figure out size of file
>     fseek(file, 0, SEEK_END);
>     int size = ftell(file);
>     rewind(file);
>
>     // go to start of second line
>     while((ch = fgetc(file)) != EOF) {
>       size--;
>       if (ch == '\n' || ch == '\r') break;
>     }
>
>     // copy remainder of script to char[]
>     char* chars = new char[size + 1];
>     for (int i = 0; i < size;) {
>       int read = fread(&chars[i], 1, size - i, file);
>       i += read;
>     }
>     chars[size] = '&#92;&#48;';
>     fclose(file);
>
>     // now execute script in char[]
>     v8::HandleScope handle_scope;
>     v8::Handle<v8::String> file_name = v8::String::New("unnamed");
>     v8::Handle<v8::String> source = v8::String::New(chars);
>     if (ExecuteString(source, file_name, false, true)) {
>       OnExit();
>       return 0;
>     }
> }
```

```
>     }
>     fclose(file);
> }
>
```

Here is a simple JavaScript script (*fib.js*) that uses the *d8* shell (to which */usr/bin/d8js* is linked) and the *shebang* functionality. Just like a shell script, it can be invoked as *./fib.js* or with its full pathname.

```
#!/usr/bin/d8js
function fibonacci(num) {
  var curnum = 1
  var prevnum = 0;
  for(i=0;i<=num;i++){
    curnum = curnum + prevnum;
    prevnum = curnum;
  }
  print("Fibonacci number for: " + num + " is: " + curnum);
}
while (1) {
  write("Enter number greater than 1, or 0 to exit: ");
  if (( num = readline()) == 0)
    break;
  fibonacci(num);
}
```

Note the use of *write()* to output a prompt prior to reading in a value using *readline()*.

Here is how to build the regular V8 shell on an X64 platform:

```
$ scons arch=x64 sample=shell
```

Like the *d8* shell it does not support *shebang* functionality nor does it support command history or command completion.

I modified *./samples/shell.cc* to add *shebang* functionality and command history support. Initially I intended adding command completion support but dropped it due to lack of time. It turns out that command completion is implemented in an interesting way in the *d8* shell. It is actually implemented in JavaScript (see *GetCompletions* function *./src/d8.js*) and then converted into C-style char arrays (*natives*) using the Python script *./tools/js2c.py*. The c++ source file that is created by this tool and which is subsequently compiled and linked in is *./obj/.libraries.cc*.

Here are the necessary diffs to *./samples/shell.cc* to support *shebang* and command line history:

```
diff samples/shell.cc.org samples/shell.cc.new
28c28,29
< #include <v8.h>
---
> #include "../src/d8.h"
>
34,36c35,45
< void RunShell(v8::Handle<v8::Context> context);
< bool ExecuteString(v8::Handle<v8::String> source,
<                   v8::Handle<v8::Value> name,
---
> #include <cstdio>
> #include <readline/readline.h>
```

```

> #include <readline/history.h>
>
> namespace v8 {
>
> namespace i = internal;
>
> void RunShell(Handle<Context> context);
> bool ExecuteString(Handle<String> source,
>                   Handle<Value> name,
39,45c48,159
< v8::Handle<v8::Value> Print(const v8::Arguments& args);
< v8::Handle<v8::Value> Read(const v8::Arguments& args);
< v8::Handle<v8::Value> Load(const v8::Arguments& args);
< v8::Handle<v8::Value> Quit(const v8::Arguments& args);
< v8::Handle<v8::Value> Version(const v8::Arguments& args);
< v8::Handle<v8::String> ReadFile(const char* name);
< void ReportException(v8::TryCatch* handler);
---
> Handle<Value> Print(const Arguments& args);
> Handle<Value> Read(const Arguments& args);
> Handle<Value> Write(const Arguments& args);
> Handle<Value> Load(const Arguments& args);
> Handle<Value> Quit(const Arguments& args);
> Handle<Value> Version(const Arguments& args);
> Handle<String> ReadFile(const char* name);
> Handle<Value> ReadLine(const Arguments& args);
> void ReportException(TryCatch* handler);
>
> // ----- readline support
> class ReadLineEditor: public LineEditor {
> public:
>   ReadLineEditor() : LineEditor(LineEditor::READLINE, "readline") { }
>   virtual i::SmartPointer<char> Prompt(const char* prompt);
>   virtual bool Open();
>   virtual bool Close();
>   virtual void AddHistory(const char* str);
> };
>
>
> const char* kHistoryFileName = ".v8_history";
> const char* kPrompt = "v8> ";
> Persistent<Context> utility_context_;
> Persistent<Context> evaluation_context_;
> LineEditor *LineEditor::first_ = NULL;
>
>
> LineEditor::LineEditor(Type type, const char* name)
>   : type_(type),
>   name_(name),
>   next_(first_) {
>   first_ = this;
> }
>
>
> LineEditor* LineEditor::Get() {
>   LineEditor* current = first_;
>   LineEditor* best = current;
>   while (current != NULL) {
>     if (current->type_ > best->type_)
>       best = current;
>     current = current->next_;
>   }
>   return best;
> }
>
>
> class DumbLineEditor: public LineEditor {
> public:

```

```

> DumbLineEditor() : LineEditor(LineEditor::DUMB, "dumb") { }
> virtual i::SmartPointer<char> Prompt(const char* prompt);
> };
>
>
> i::SmartPointer<char> DumbLineEditor::Prompt(const char* prompt) {
> static const int kBufferSize = 256;
> char buffer[kBufferSize];
> printf("%s", prompt);
> char* str = fgets(buffer, kBufferSize, stdin);
> return i::SmartPointer<char>(str ? i::StrDup(str) : str);
> }
>
>
> static ReadLineEditor read_line_editor;
>
> bool ReadLineEditor::Open() {
> rl_initialize();
> using_history();
> return read_history(kHistoryFileName) == 0;
> }
>
>
> bool ReadLineEditor::Close() {
> return write_history(kHistoryFileName) == 0;
> }
>
>
> i::SmartPointer<char> ReadLineEditor::Prompt(const char* prompt) {
> char* result = readline(prompt);
> return i::SmartPointer<char>(result);
> }
>
>
> void ReadLineEditor::AddHistory(const char* str) {
> add_history(str);
> }
>
>
> static char* ReadToken(char* data, char token) {
> char* next = i::OS::StrChr(data, token);
> if (next != NULL) {
> *next = '\0';
> return (next + 1);
> }
>
> return NULL;
> }
>
>
> Handle<Value> ReadLine(const Arguments& args) {
> i::SmartPointer<char> line(i::ReadLine(""));
> if (*line == NULL) {
> return Null();
> }
> size_t len = strlen(*line);
> if (len > 0 && line[len - 1] == '\n') {
> --len;
> }
> return String::New(*line, len);
> }
>
> // ----- readline support
49,62c163
< v8::V8::SetFlagsFromCommandLine(&argc, argv, true);
< v8::HandleScope handle_scope;
< // Create a template for the global object.
< v8::Handle<v8::ObjectTemplate> global = v8::ObjectTemplate::New();
< // Bind the global 'print' function to the C++ Print callback.

```

```

< global->Set(v8::String::New("print"), v8::FunctionTemplate::New(Print));
< // Bind the global 'read' function to the C++ Read callback.
< global->Set(v8::String::New("read"), v8::FunctionTemplate::New(Read));
< // Bind the global 'load' function to the C++ Load callback.
< global->Set(v8::String::New("load"), v8::FunctionTemplate::New(Load));
< // Bind the 'quit' function
< global->Set(v8::String::New("quit"), v8::FunctionTemplate::New(Quit));
< // Bind the 'version' function
< global->Set(v8::String::New("version"), v8::FunctionTemplate::New(Version));
---
> V8::SetFlagsFromCommandLine(&argc, argv, true);
63a165,167
> // FPM HandleScope handle_scope;
> HandleScope handle;
> Handle<ObjectTemplate> global = ObjectTemplate::New();
64a169,176
> global->Set(String::New("print"), FunctionTemplate::New(Print));
> global->Set(String::New("read"), FunctionTemplate::New(Read));
> global->Set(String::New("write"), FunctionTemplate::New(Write));
> global->Set(String::New("load"), FunctionTemplate::New(Load));
> global->Set(String::New("quit"), FunctionTemplate::New(Quit));
> global->Set(String::New("version"), FunctionTemplate::New(Version));
> global->Set(String::New("readline"), FunctionTemplate::New(ReadLine));
>
67c179
< v8::Handle<v8::Context> context = v8::Context::New(NULL, global);
---
> Handle<Context> context = Context::New(NULL, global);
69c181
< v8::Context::Scope context_scope(context);
---
> Context::Scope context_scope(context);
71a184,219
> FILE* file = fopen(argv[1], "rb");
> if (file) {
>     int ch = fgetc(file);
>     int ch1 = fgetc(file);
>     if (ch == '#' && ch1 == '!') { // #! shebang
>         // figure out size of file
>         fseek(file, 0, SEEK_END);
>         int size = ftell(file);
>         rewind(file);
>
>         // go to start of second line
>         while((ch = fgetc(file)) != EOF) {
>             size--;
>             if (ch == '\n' || ch == '\r') break;
>         }
>
>         // copy remainder of script to char[]
>         char* chars = new char[size + 1];
>         for (int i = 0; i < size; i) {
>             int read = fread(&chars[i], 1, size - i, file);
>             i += read;
>         }
>         chars[size] = '&#92;&#48;';
>         fclose(file);
>
>         // now execute script in char[]
>         HandleScope handle_scope;
>         Handle<String> file_name = String::New("unnamed");
>         Handle<String> source = String::New(chars);
>         if (ExecuteString(source, file_name, false, true)) {
>             return 0;
>         }
>     }
>     fclose(file);
> }

```

```

>
84,86c232,234
<   v8::HandleScope handle_scope;
<   v8::Handle<v8::String> file_name = v8::String::New("unnamed");
<   v8::Handle<v8::String> source = v8::String::New(argv[i + 1]);
---
>   HandleScope handle_scope;
>   Handle<String> file_name = String::New("unnamed");
>   Handle<String> source = String::New(argv[i + 1]);
92,94c240,242
<   v8::HandleScope handle_scope;
<   v8::Handle<v8::String> file_name = v8::String::New(str);
<   v8::Handle<v8::String> source = ReadFile(str);
---
>   HandleScope handle_scope;
>   Handle<String> file_name = String::New(str);
>   Handle<String> source = ReadFile(str);
107,114d254
<
< int main(int argc, char* argv[]) {
<   int result = RunMain(argc, argv);
<   v8::V8::Dispose();
<   return result;
< }
<
<
116c256
< const char* ToCString(const v8::String::Utf8Value& value) {
---
> const char* ToCString(const String::Utf8Value& value) {
124c264
< v8::Handle<v8::Value> Print(const v8::Arguments& args) {
---
> Handle<Value> Print(const Arguments& args) {
127c267
<   v8::HandleScope handle_scope;
---
>   HandleScope handle_scope;
133c273
<   v8::String::Utf8Value str(args[i]);
---
>   String::Utf8Value str(args[i]);
139c279
<   return v8::Undefined();
---
>   return Undefined();
146c286
< v8::Handle<v8::Value> Read(const v8::Arguments& args) {
---
> Handle<Value> Read(const Arguments& args) {
148c288
<   return v8::ThrowException(v8::String::New("Bad parameters"));
---
>   return ThrowException(String::New("Bad parameters"));
150c290
<   v8::String::Utf8Value file(args[0]);
---
>   String::Utf8Value file(args[0]);
152c292
<   return v8::ThrowException(v8::String::New("Error loading file"));
---
>   return ThrowException(String::New("Error loading file"));
154c294
<   v8::Handle<v8::String> source = ReadFile(*file);
---
>   Handle<String> source = ReadFile(*file);
156c296
<   return v8::ThrowException(v8::String::New("Error loading file"));

```

```

---
> return ThrowException(String::New("Error loading file"));
161a302,318
> Handle<Value> Write(const Arguments& args) {
>   for (int i = 0; i < args.Length(); i++) {
>     HandleScope handle_scope;
>     if (i != 0) {
>       printf(" ");
>     }
>     String::Utf8Value str(args[i]);
>     int n = fwrite(*str, sizeof(**str), str.length(), stdout);
>     if (n != str.length()) {
>       printf("Error in fwrite\n");
>       exit(1);
>     }
>   }
>   return Undefined();
> }
>
>
165c322
< v8::Handle<v8::Value> Load(const v8::Arguments& args) {
---
> Handle<Value> Load(const Arguments& args) {
167,168c324,325
<   v8::HandleScope handle_scope;
<   v8::String::Utf8Value file(args[i]);
---
>   HandleScope handle_scope;
>   String::Utf8Value file(args[i]);
170c327
<   return v8::ThrowException(v8::String::New("Error loading file"));
---
>   return ThrowException(String::New("Error loading file"));
172c329
<   v8::Handle<v8::String> source = ReadFile(*file);
---
>   Handle<String> source = ReadFile(*file);
174c331
<   return v8::ThrowException(v8::String::New("Error loading file"));
>   return ThrowException(String::New("Error loading file"));
176,177c333,334
<   if (!ExecuteString(source, v8::String::New(*file), false, false)) {
<     return v8::ThrowException(v8::String::New("Error executing file"));
---
>   if (!ExecuteString(source, String::New(*file), false, false)) {
>     return ThrowException(String::New("Error executing file"));
180c337
<   return v8::Undefined();
---
>   return Undefined();
186c343
< v8::Handle<v8::Value> Quit(const v8::Arguments& args) {
---
> Handle<Value> Quit(const Arguments& args) {
191c348
<   return v8::Undefined();
---
>   return Undefined();
195,196c352,353
< v8::Handle<v8::Value> Version(const v8::Arguments& args) {
<   return v8::String::New(v8::V8::GetVersion());
---
> Handle<Value> Version(const Arguments& args) {
>   return String::New(V8::GetVersion());
201c358
< v8::Handle<v8::String> ReadFile(const char* name) {
---

```



```

> Handle<String> ReadFile(const char* name) {
203c360
<   if (file == NULL) return v8::Handle<v8::String>();
---
>   if (file == NULL) return Handle<String>();
216c373
<   v8::Handle<v8::String> result = v8::String::New(chars, size);
---
>   Handle<String> result = String::New(chars, size);
223,228c380,383
< void RunShell(v8::Handle<v8::Context> context) {
<   // LineEditor* editor = LineEditor::Get();
<   // printf("V8 version %s [console: %s]\n", v8::V8::GetVersion(), editor->name());
<
<   // printf("V8 version %s\n", v8::V8::GetVersion());
<   static const int kBufferSize = 256;
---
> void RunShell(Handle<Context> context) {
>   LineEditor* editor = LineEditor::Get();
>   printf("V8 version %s [console: %s]\n", V8::GetVersion(), editor->name());
>   editor->Open();
230,238c385,390
<   char buffer[kBufferSize];
<   printf("> ");
<   char* str = fgets(buffer, kBufferSize, stdin);
<   if (str == NULL) break;
<   v8::HandleScope handle_scope;
<   ExecuteString(v8::String::New(str),
<                 v8::String::New("(shell)"),
<                 true,
<                 true);
---
>   i::SmartPointer<char> input = editor->Prompt(kPrompt);
>   if (input.is_empty())
>       break;
>   editor->AddHistory(*input);
>   Handle<String> name = String::New("(v8)");
>   ExecuteString(String::New(*input), name, true, true);
239a392
>   editor->Close();
245,246c398,399
< bool ExecuteString(v8::Handle<v8::String> source,
<                   v8::Handle<v8::Value> name,
---
> bool ExecuteString(Handle<String> source,
>                   Handle<Value> name,
249,251c402,404
<   v8::HandleScope handle_scope;
<   v8::TryCatch try_catch;
<   v8::Handle<v8::Script> script = v8::Script::Compile(source, name);
---
>   HandleScope handle_scope;
>   TryCatch try_catch;
>   Handle<Script> script = Script::Compile(source, name);
258c411
<   v8::Handle<v8::Value> result = script->Run();
---
>   Handle<Value> result = script->Run();
268c421
<   v8::String::Utf8Value str(result);
---
>   String::Utf8Value str(result);
278,280c431,433
< void ReportException(v8::TryCatch* try_catch) {
<   v8::HandleScope handle_scope;
<   v8::String::Utf8Value exception(try_catch->Exception());
---
> void ReportException(TryCatch* try_catch) {

```

```

> HandleScope handle_scope;
> String::Utf8Value exception(try_catch->Exception());
282c435
< v8::Handle<v8::Message> message = try_catch->Message();
---
> Handle<Message> message = try_catch->Message();
289c442
< v8::String::Utf8Value filename(message->GetScriptResourceName());
---
> String::Utf8Value filename(message->GetScriptResourceName());
294c447
< v8::String::Utf8Value sourceline(message->GetSourceLine());
---
> String::Utf8Value sourceline(message->GetSourceLine());
307c460
< v8::String::Utf8Value stack_trace(try_catch->StackTrace());
---
> String::Utf8Value stack_trace(try_catch->StackTrace());
313a467,474
>
> } // namespace V8
>
> int main(int argc, char* argv[]) {
>   int result = v8::RunMain(argc, argv);
>   v8::V8::Dispose();
>   return result;
> }

```

To support the changes name in `../samples/shell.cc`, the toplevel `SConstruct` file also has to be modified to add in `../src` as an include directory and to add `libreadline` to the list of libraries to be linked in.

```

$ diff SConstruct.org SConstruct,new
453c453
<   'CPPPATH': [join(abspath('.'), 'include')],
---
>   'CPPPATH': [join(abspath('.'), 'include'), join(abspath('.'), 'src')]
461c461
<   'LIBS':      ['pthread'],
---
>   'LIBS':      ['pthread', 'readline'],

```

Here is another simple JavaScript script (`des.js`) which imports (loads) another Javascript file (`des-inc.js`) containing the actual DES encryption routines and then performs a TripleDES encryption on a user supplied string using a user supplied key. It uses `/usr/bin/v8js` which is linked to to the `samples` shell.

```

#!/usr/bin/v8js
load("../des-inc.js");
function stringToHex (s) {
  var hexes = new Array ("0","1","2","3","4","5","6","7","8","9","a","b","c","d","e","f")
  ;
  var r="";
  for (var i=0; i<s.length; i++) {
    r += hexes [s.charCodeAt(i) >> 4] + hexes [s.charCodeAt(i) & 0xf];
  }
  return r;
}
var key = "1234567890123456ABCDEFGH";
var plaintext = "The quick brown fox jumped over the lazy dog";
while (true) {
  write("Enter 24 character key or 0 to exit [" + key + "]: ");

```

```

input = readline();
if (input == "0") quit();
if (input.length == 0) break;
if (input.length == 24) {
    key = input;
    break;
}
}
while (true) {
    write("Enter plaintext or 0 to exit [" + plaintext + "]: ");
    input = readline();
    if (input == "0") quit();
    if (input.length == 0) break;
    if (input.length >= 24) {
        plaintext = input;
        break;
    }
}
var ciphertext = des(key, plaintext, 1, 0);
print("Ciphertext: " + stringToHex(ciphertext));

```

I did not write the JavaScript code for the [DES encryption](#) routines in *des-inc.js*. The original author of these routines was Paul Tero, a web programmer based in Brighton, England.

Here is sample output from *des.js*:

```

$ ./des.js
Enter 24 character key or 0 to exit [1234567890123456ABCDEFGH]: 123456789012345678901234
Enter plaintext or 0 to exit [The quick brown fox jumped over the lazy dog]:
Ciphertext: 01dfc133e39f20cce77732a2bb45838ee4020248ce8866b685d49042ac85234a26a08ed18cde40
e33c20206b54e6af9f
$

```

Well that is all for now. If I get some spare time, I would like to implement *readline* completions. The main problem will be modifying the *SConstruct* and *SConfig* build configurations files.

P.S. The V8 codebase is updated frequently so some work may be needed to integrate my changes into a more recent snapshot of the codebase. The trunk snapshot which I used was dated December 12th, 2010. If you want to use a tagged version rather than pull from the trunk, that is now possible, e.g. to get the v8-2.5.9 snapshot:

```

$ svn export http://v8.googlecode.com/svn/tags/2.5.9/ v8-2.5.9

```