Refactoring C++ with Clang

Let's make C++ more fun than Java

Performance

Productivity

Fun

Performance

Productivity

Fun

Performance **Excellent!**

Productivity

Fun

Performance **Excellent!**

Productivity **… mixed**

Fun

Performance **Excellent!**

Productivity **… mixed**

Fun **… hmmm**

From: PedanticGuy
Subject: [PATCH] Awesome new feature

On Wed, March 7, 2011 NewContributor wrote:
> + void DoSomethingAwesome(Cats cats);

ALL your methods are capitalized incorrectly...
Please fix. Thx.

Tooling & Automation

Tooling & Automation

- Code Formatting
- Renaming
- Boilerplate

Tooling & Automation is Hard!

- Cross-TU
- Build systems & editors
- SPEED!

Clang

Tooling

Clang

Tooling

Refactoring

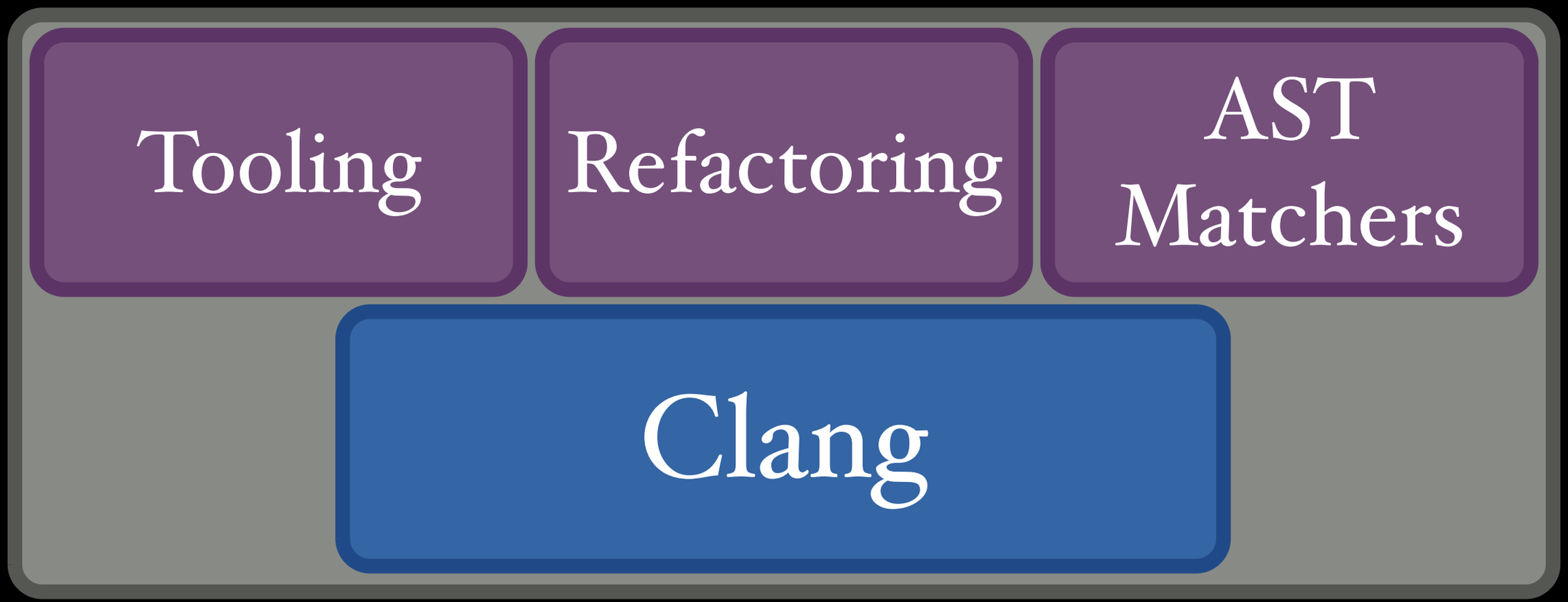
Clang

Tooling

Refactoring

AST Matchers

Clang


Tooling
Refactoring
AST Matchers
Clang

Plugins

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libclang

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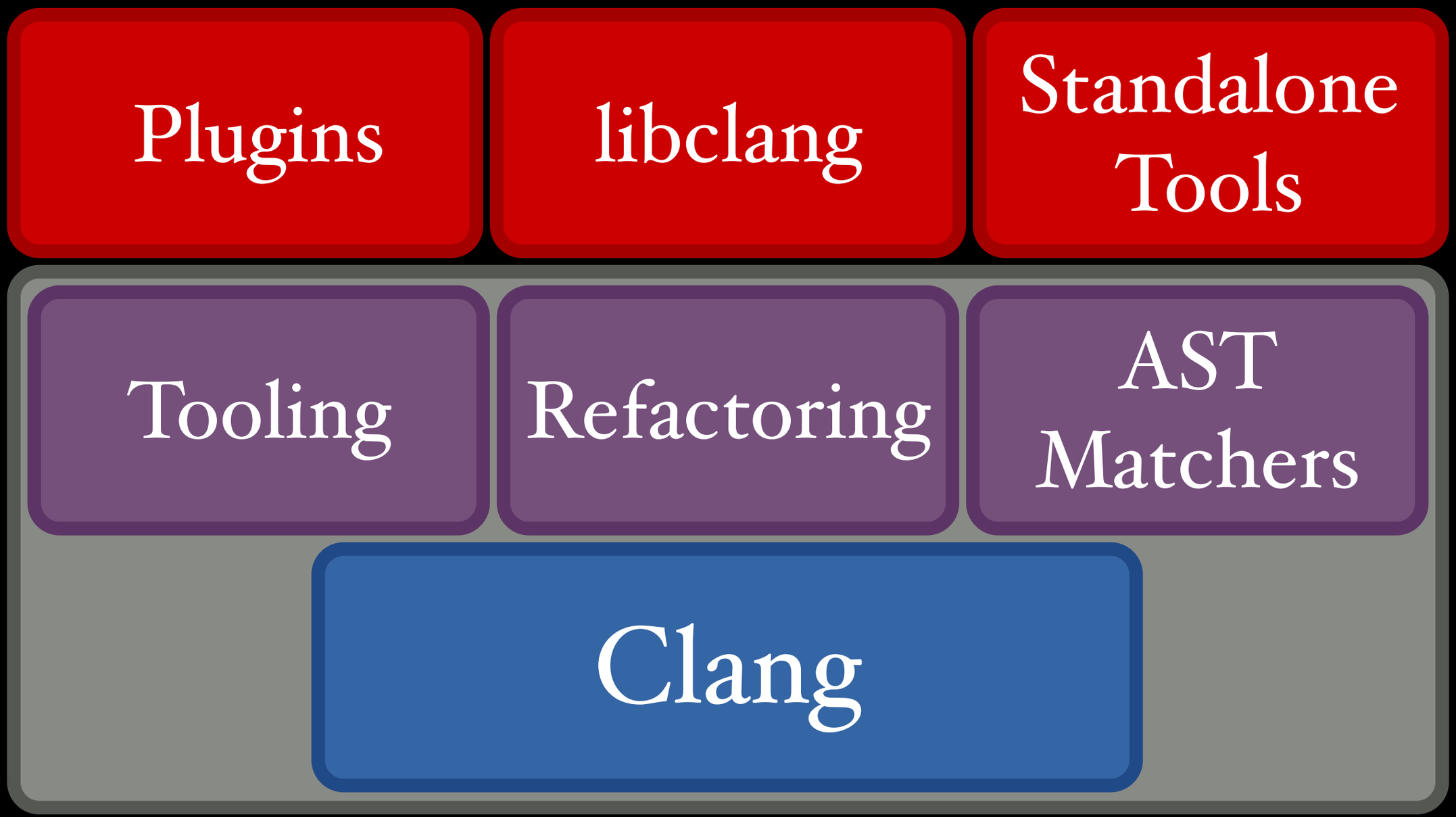
Plugins
libclang
Standalone Tools
Tooling
Refactoring
AST Matchers
Clang

Standalone Refactoring Tools

A Case Study:
Refactoring APIs

```
class MyElements
      : public ElementsBase {
  virtual const Element &Get();
};

Element f(const MyElements &E) {
  // ...
  return E.Get();
}
```

```
class MyElements
      : public ElementsBase {
   virtual const Element &Get();
};
```

```
Element f(const MyElements &E) {
   // ...
   return E.Get();
}
```

```
class MyElements
      : public ElementsBase {
  virtual const Element &Front();
};
```

```
Element f(const MyElements &E) {
  // ...
  return E.Front();
}
```

First, we need a tool to run over our code...

```
// Declare global command line flags.

cl::opt<std::string> BuildPath(
    cl::Positional,
    cl::desc("<build-path>"));

cl::list<std::string> SourcePaths(
    cl::Positional,
    cl::desc("<source0> [... <sourceN>]"),
    cl::OneOrMore);
```

```
int main(int argc, char **argv) {
  cl::ParseCommandLineOptions(argc, argv);
  string ErrorMessage;
  OwningPtr<CompilationDatabase> Compilations(
    CompilationDatabase::loadFromDirectory(
      BuildPath, ErrorMessage));
  if (!Compilations)
    report_fatal_error(ErrorMessage);
  RefactoringTool Tool(*Compilations,
                       SourcePaths);
  // ... magic ...
  return Tool.run(
    newFrontendActionFactory(...));
}
```

```
[
{
  "directory": "/work/project",
  "command":
    "/usr/bin/c++ -o code.cc.o -c code.cc",
  "file": "/work/project/code.cc"
},
{
  "directory": "/work/project",
  "command":
    "/usr/bin/c++ -o code2.cc.o -c code2.cc",
  "file": "/work/project/code2.cc"
},
...
```

```
int main(int argc, char **argv) {
  cl::ParseCommandLineOptions(argc, argv);
  string ErrorMessage;
  OwningPtr<CompilationDatabase> Compilations(
    CompilationDatabase::loadFromDirectory(
      BuildPath, ErrorMessage));
  if (!Compilations)
    report_fatal_error(ErrorMessage);
  RefactoringTool Tool(*Compilations,
                       SourcePaths);
  // ... magic ...
  return Tool.run(
    newFrontendActionFactory(...));
}
```

Magic you ask?

AST Matchers: A predicate library for Clang ASTs

Code snippet:

```
e = elements.Get(42);
f = fish->Get(23);
f.Cook();
feed();
```

Code snippet:

```
e = elements.Get(42);
f = fish->Get(23);
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```

Matcher:

```
Call()
```

Code snippet:

```
e = elements.Get(42);
f = fish->Get(23);
f.Cook();
feed();
```

Matcher:

```
Call(
  Callee(...))
```

Code snippet:

```
e = elements.Get(42);
f = fish->Get(23);
f.Cook();
feed();
```

Matcher:

```
Call(
  Callee(Method()))
```

Code snippet:

```
e = elements.Get(42);
f = fish->Get(23);
f.Cook();
feed();
```

Matcher:

```
Call(
  Callee(Method(HasName("Get"))))
```

Code snippet:

```
e = elements.Get(42);
f = fish->Get(23);
f.Cook();
feed();
```

Matcher:

```
Call(
  Callee(Method(HasName("Get"))),
  ThisPointerType(...))
```

Code snippet:

```
e = elements.Get(42);
f = fish->Get(23);
f.Cook();
feed();
```

Matcher:

```
Call(
  Callee(Method(HasName("Get"))),
  ThisPointerType(Class(
    IsDerivedFrom("ElementsBase"))))
```

Ok, let’s use magic!

```
  // Magic:
  MatchFinder Finder;
  CallRenamer CallCallback(
    &Tool.getReplacements());
  Finder.addMatcher(
    Call(
      Callee(Method(HasName("Get"))),
        ThisPointerType(Class(
            IsDerivedFrom("ElementsBase")))),
      &CallCallback);

  return Tool.run(
    newFrontendActionFactory(&Finder));
}
```

```
class CallRenamer
    : public MatchFinder::MatchCallback {
  Replacements *Replace;

 public:
  CallRenamer(Replacements *Replace)
    : Replace(Replace) {}

  virtual void run(
    const MatchFinder::MatchResult &Result);
};
```

```
MatchFinder Finder;
Renamer Callback(&Tool.getReplacements());
Finder.addMatcher(
  Call(
    Callee(Method(HasName("Get"))),
    ThisPointerType(Class(
        IsDerivedFrom("ElementsBase")))),
    Callee(Id("member",
              MemberExpression()))),
&Callback);
```

```
void CallRenamer::run(
    const MatchFinder::MatchResult &Result) {

  const MemberExpr *M =
    Result.Nodes.getStmtAs<MemberExpr>(
      "member");

  Replace->insert(Replacement(
    *Result.SourceManager,
    CharSourceRange::getTokenRange(
      SourceRange(M->getMemberLoc()))),
    "Front"));
}
```

```
// More magic:
DeclRenamer DeclCallback(
  &Tool.getReplacements());
Finder.addMatcher(Id("method",
    Method(
      HasName("Get"),
      OfClass(
        IsDerivedFrom(
          "ElementsBase")))),
&DeclCallback);
```

```
void DeclRenamer::run(
    const MatchFinder::MatchResult &Result) {

  const CXXMethodDecl *D =
    Result.Nodes.getDeclAs<CXXMethodDecl>(
      "method");

  Replace->insert(
    Replacement(
      *Result.SourceManager,
      CharSourceRange::getTokenRange(
        SourceRange(D->getLocation())),
      "Front"));
}
```

There’s more magic!

```
Finder.addMatcher(
  ConstructorCall(
    HasDeclaration(Method(
        HasName(StringConstructor))),
    ArgumentCountIs(2),
    HasArgument(
      0,
      Id("call", Call(
          Callee(Id("member",
                    MemberExpression()))),
          Callee(Method(
              HasName(StringCStrMethod))),
          On(Id("arg", Expression()))))),
  HasArgument(
    1,
    DefaultArgument())),
&Callback);
```

Go write tools!

Source Code

Open Source branch of Clang:

http://llvm.org/svn/llvm-project/cfe/branches/tooling

Rename example code:

.../examples/rename-interface/RenameInterface.cpp

Remove string::c_str calls code:

.../tools/remove-cstr-calls/RemoveCStrCalls.cpp