Eclipse CDT code analysis and unit testing

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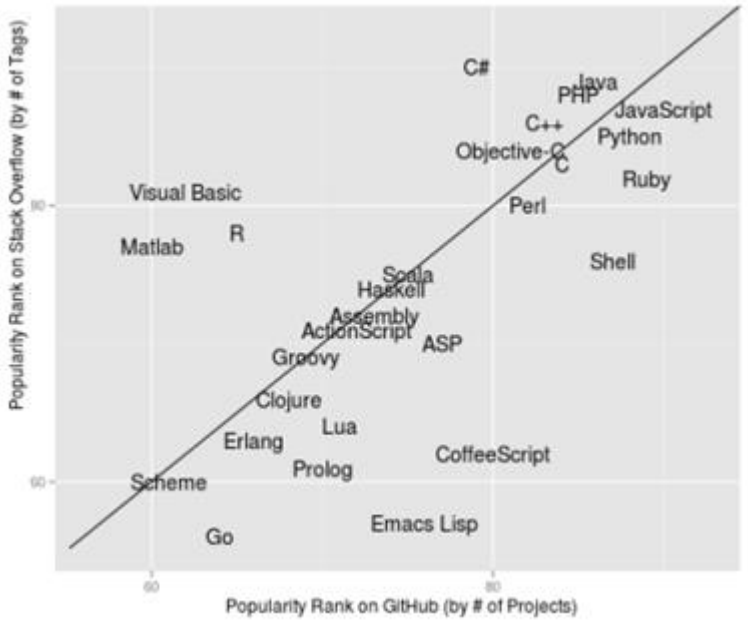
Agenda

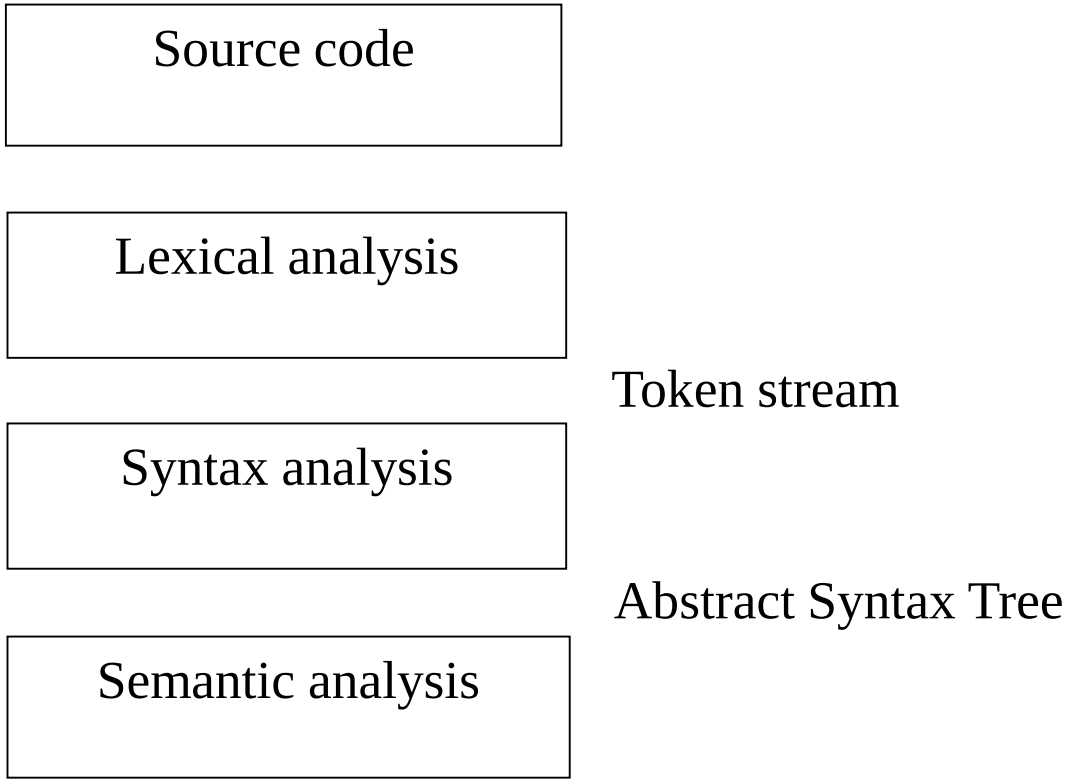
- Compilers and translators
- Eclipse Plugin
- CDT
- AST
- Visitor

Compilers and translators

- Compilers translate information from one representation to another.
- Most commonly, the information is a program
- Compilers translate from high-level source code to low-level code
- Translators transform representations at the same level of abstraction



Stages of Compilation



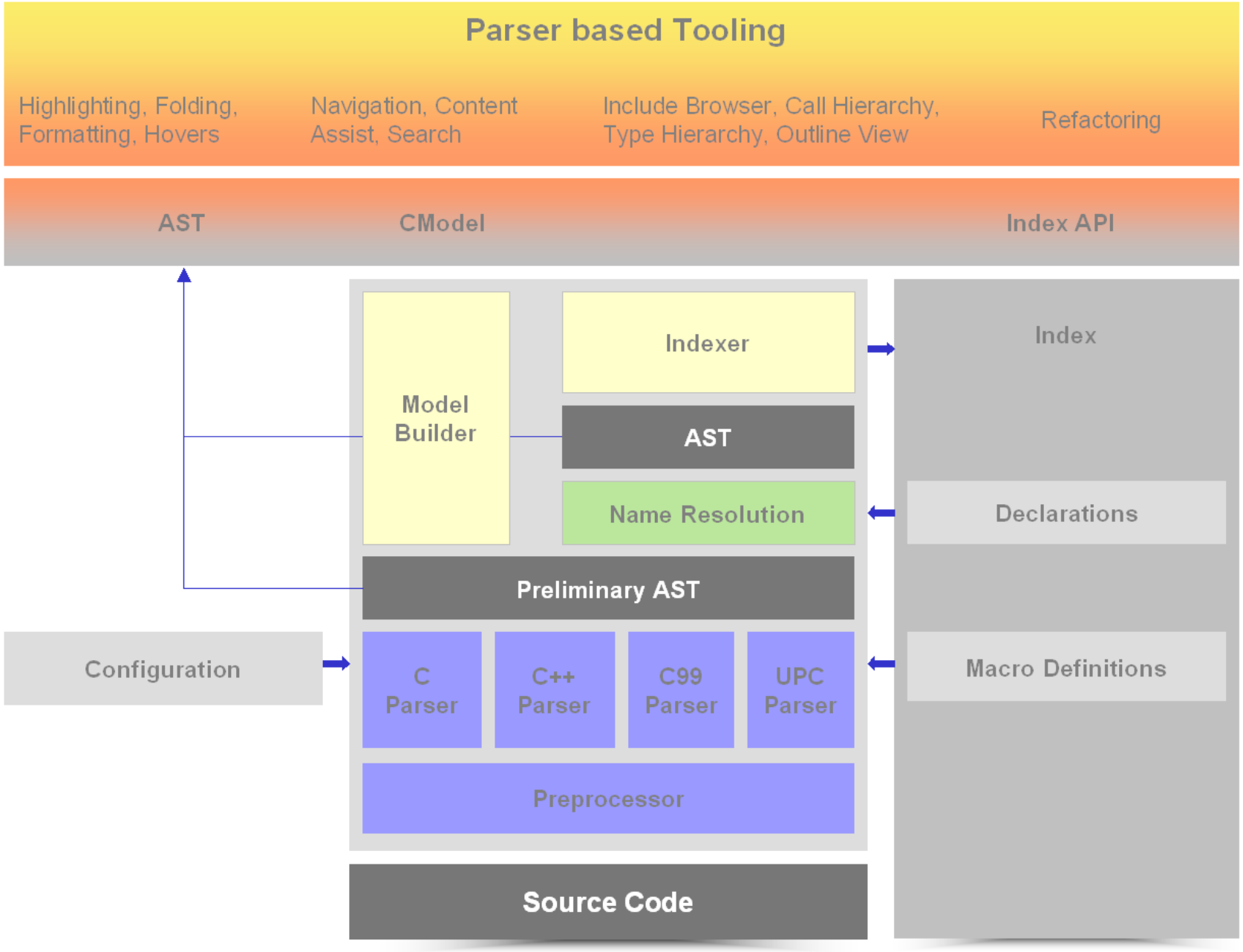
- AST represents the structure of the source code
- Parser turns flat text into a tree
- AST is a kind of a program intermediate form (IR).

Eclipse

- IDE – Integrated Development Environment
- Support several programming languages
  - C/C++, Java, PHP, XML, HTML
- Multi-platform
  - Windows, Linux
- Supports plug-in functionality
- Open source
- Alternatives – NetBeans, MS Visual Studio, g++

CDT (C/C++ Development Tooling)

- Set of plug-in for developing C/C++ applications
- Edit/compile/debug/run
- CDT parses and analyses the code
- CDT compiles the code into an index file
- Index stores information
  - Identifier Bindings
  - Location source file, offset
  - Macros
  - Include files
- JDT (Java Development Tools)
- PDE (Plug-in Development Environment)



http://wiki.eclipse.org/CDT/designs/Overview_of_Parsing

CDT core

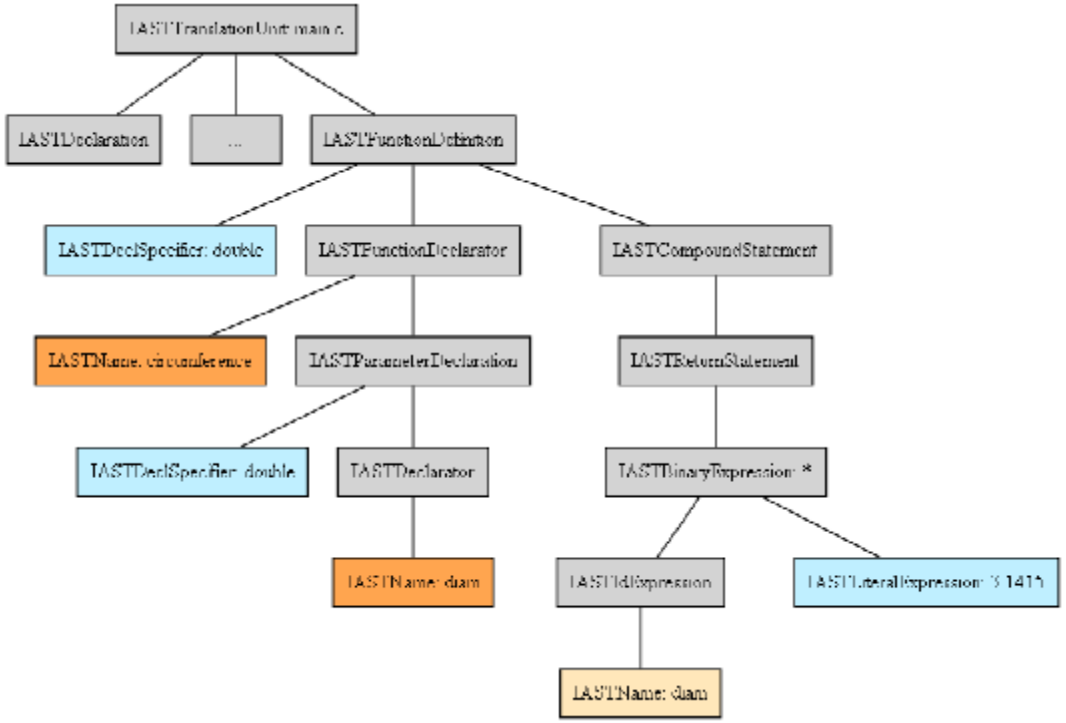
- Preprocessor
  - Extra stage between the lexer and parser
  - Converts text into token stream
- Parsers (C and C++)
  - Converts token stream into an AST
- AST
  - Visitor API
- AST Rewrite API
  - Implement refactoring
- Semantic analysis
  - Resolve identifiers
- Indexer
  - Update index file by processing the AST
- Index API
  - Index based tool to query the index

CDT indexer

- Indexer
  - Code traversal and searching
- Refactoring
  - Rename function / method
- Indexer used with static code analysis

AST

- AST represents the structure of the source code
- CDT functionality is based on the AST
  - ~90 classes for C++
- Implement common interfaces
  - Some algorithms depend on specific type – semantic analysis
  - Some algorithms depend on interfaces – outline view



Access to C-model and C-index

- C-Model: ITranslationUnit for a workspace file

```
IPath path = new Path("project/folder/file.cpp");
IFile file = ResourcesPlugin.getWorkspace().getRoot().getFile(path);
// Create translation unit for file
ITranslationUnit tu= (ITranslationUnit) CoreModel.getDefault().create(file);
```

- C-Model: ITranslationUnit for file in the editor

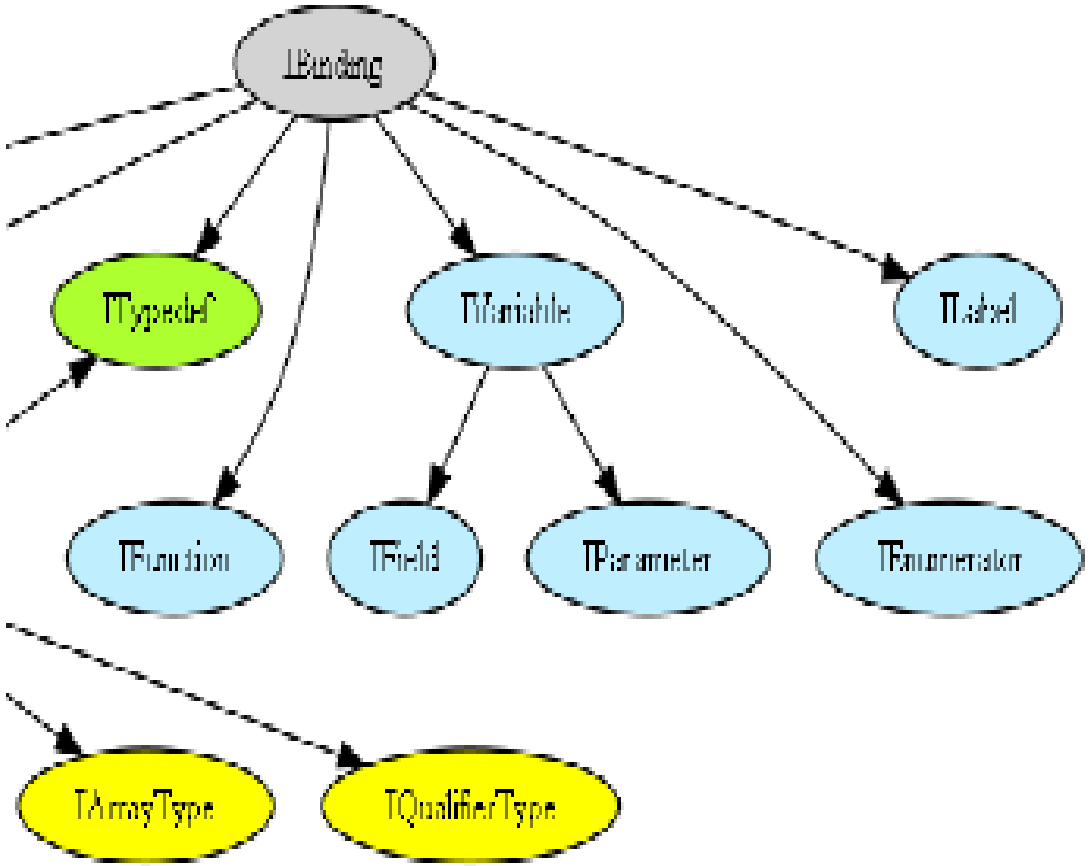
```
IEditorPart e =
  PlatformUI.getWorkbench().getActiveWorkbenchWindow().getActivePage().getActiveEdit
  or();
// Access translation unit of the editor.
ITranslationUnit tu = (ITranslationUnit)
  CDTUITools.getEditorInputCElement(editor.getEditorInput());
```

- C-Index: IIndex for project

```
ICProject project = CoreModel.getDefault().getCModel().getCProject("project");
IIndex index = CCorePlugin.getIndexManager().getIndex(project);
```

Binding and types

- Index contains information
  - Include directives and macro definitions
  - Non-local declarations
  - References to macros and non-local declarations
  - File location for each include, macro definition, declaration and reference
  - Binding for each name
- Completely represent C/C++ entities
  - Type of a variable, return type and parameters for a function
  - Fields of a composite type, owner of a field



Creating AST

- Complete AST: IASTTranslationUnit for a workspace file

```
ITranslationUnit tu = …;
IASTTranslationUnit ast = tu.getAST();
```

- Index-based AST: IASTTranslationUnit for a workspace file

```
IIndex index = …;
ITranslationUnit tu = …;
index.acquireReadLock(); // we need a read-lock on the index
try {
  ast = tu.getAST(index, ITranslationUnit.AST_SKIP_INDEXED_HEADERS);
} finally {
  index.releaseReadLock();
  ast = null; // don't use the ast after releasing the read-lock
}
```

Visitor pattern

- Design pattern used to traverse the AST
- Standard easy-to-use API for processing the AST
- Create a visitor object
  - Extends ASTVisitor
  - Implement overloaded visit(IASTXXX) methods for each node type
- Each node class has an accept(ASTVisitor) method (defined in IASTNode)
  - Calls visit(this)

Walk AST – Visitor pattern

```
private void walkITU_AST(ITranslationUnit tu) throws CoreException {
	System.out.println("AST visitor for " + tu.getElementName());
	IASTTranslationUnit ast = tu.getAST();
	ast.accept(new ASTPrinter());
}
class ASTPrinter extends ASTVisitor{
	ASTPrinter(){
		this.shouldVisitStatements = true;
		this.shouldVisitDeclarations = true;
	}
public int visit(IASTStatement stmt) {
		System.out.println("Visiting stmt: " + stmt.getRawSignature());
		return PROCESS_CONTINUE;
	}
public int visit(IASTDeclaration decl) {
		System.out.println("Visiting decl: " + decl.getRawSignature());
		return PROCESS_CONTINUE;
	}                                                    Tree.accept(visitor)
}
```

AST output

- Source and results

```
#include <iostream>
int foo() {
  return 0;
}
class a {
a() {};
void b() {};
};
int main() {
  std::cout << "foo" << std::endl;
  foo();
  a b1;
  return 0;
}
```

```
Visiting decl: int foo() {  return 0; }
    Visiting stmt: {  return 0; }
        Visiting stmt: return 0;
        Leaving stmt: return 0;
    Leaving stmt: {  return 0; }
Leaving decl: int foo() {  return 0; }
Visiting decl: class a {  a() {};  void b() {}; };
    Visiting decl: a() {}
        Visiting stmt: {}
        Leaving stmt: {}
    Leaving decl: a() {}
    Visiting decl: ;
    Leaving decl: ;
    Visiting decl: void b() {}
        Visiting stmt: {}
        Leaving stmt: {}
    Leaving decl: void b() {}
    Visiting decl: ;
    Leaving decl: ;
Leaving decl: class a {  a() {};  void b() {}; };
Visiting decl: int main() {  std::cout << "foo" << std::endl; // prints foo  foo();  a b1;  return 0; }
    Visiting stmt: {  std::cout << "foo" << std::endl; // prints foo  foo();  a b1;  return 0; }
        Visiting stmt: std::cout << "foo" << std::endl;
            Visiting stmt: foo();
                Visiting stmt: a b1;
                    Visiting decl: a b1;
                    Leaving decl: a b1;
                Leaving stmt: a b1;
                Visiting stmt: return 0;
                Leaving stmt: return 0;
            Leaving stmt: {  std::cout << "foo" << std::endl; // prints foo  foo();  a b1;  return 0; }
        Leaving decl: int main() {  std::cout << "foo" << std::endl; // prints foo  foo();  a b1;  return 0; }
```

FakeStorageSCSI_DiscoveryAlgorithm.cpp

```
FakeStorageSCSI_DiscoveryAlgorithm::FakeStorag
eSCSI_DiscoveryAlgorithm()

: StorageSCSI_DiscoveryAlgorithm()

, fake_run(
"FakeStorageSCSI_DiscoveryAlgorithm::run" )

, fake_associate(
"FakeStorageSCSI_DiscoveryAlgorithm::associate
" )

, fake_getDuplicatedHardDriveList(
"FakeStorageSCSI_DiscoveryAlgorithm::getDuplic
atedHardDriveList" )

, fake_addUniqueHardDrive(
"FakeStorageSCSI_DiscoveryAlgorithm::addUnique
HardDrive" )

, fake_isDuplicateBackplane(
"FakeStorageSCSI_DiscoveryAlgorithm::isDuplica
teBackplane" )

}
```

```
void
FakeStorageSCSI_DiscoveryAlgorithm::verifyFakeMethodUsage(
const std::string& testCondition )

{

  TestUtility::verifyFakeMethodUsage( fake_run, testCondition
);

  TestUtility::verifyFakeMethodUsage( fake_associate,
testCondition );

  TestUtility::verifyFakeMethodUsage(
fake_getDuplicatedHardDriveList, testCondition );

  TestUtility::verifyFakeMethodUsage( fake_addUniqueHardDrive,
testCondition );

  TestUtility::verifyFakeMethodUsage(
fake_isDuplicateBackplane, testCondition );

}

 void FakeStorageSCSI_DiscoveryAlgorithm::run( UI_Facade&
uiFacade )

{

  return fake_run( uiFacade );

}
```

StorageSCSI_DiscoveryAlgorithmTest.cpp

```
StorageSCSI_DiscoveryAlgorithm_data()
 : fakeDeviceReporter()
 , fakeDiscoveryRepository()
 , fakeIoConnectionOperations()
 , fakeTransportFactory()
 , fakeDiscoveryOperationsFactory()
 , fakeDiscoveredDeviceOperationsFactory()
 , fakeFusionIO_AcceleratorFactory()
 , fakePciOperationsFactoryPtr( new FakePCI_OperationsFactory() )
 , fakeFileSystemOperations()
 , fakeSmbiosOperationsPtr( new FakeSMBIOS_Operations() )
 , fakeIloOperationsPtr( new iLO::Fake_iLO_Operations() )
 , fakeTimeOperationsPtr( new FakeTimeOperations() )
 , failureEventStatus( FakeEvt::failure )
 , goodEventStatus() {}
```

References

- http://gcc.gnu.org/
- CDT Project home page - http://eclipse.org/cdt
- CDT Wiki - http://wiki.eclipse.org/CDT
- API for C/C++ AST - http://help.eclipse.org/luna/index.jsp?topic=%2Forg.eclipse.cdt.doc.isv%2Fguide%2Fdom%2Findex.html

Questions ?