Phoenix: PDL and Compile-time Reflection

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Agenda

- What is Phoenix?
- PDL
- Visitor Pattern
- Object Cloning
- Compile-Time Reflection
- Phoenix Links

What is Phoenix?

- Phoenix is Microsoft's next-generation, state of the art infrastructure for program analysis and transformation

- Phoenix is used for
  - Compilers
  - Tools
  - Research
  - Instruction

What is Phoenix?

- Example Clients
  - Executable Reader/Writer
  - C++ Compiler backend
  - PreFAST (static analysis)
  - JIT
  - NGEN
  - Many more (tiger, pasm, FxCop, AST, VSInstr)
- Example Compiler Backend Plug-Ins
  - Static Analysis, Arithmetic strength reduction, Analysis Validator, Instrumented Block Count reader, …

PDL

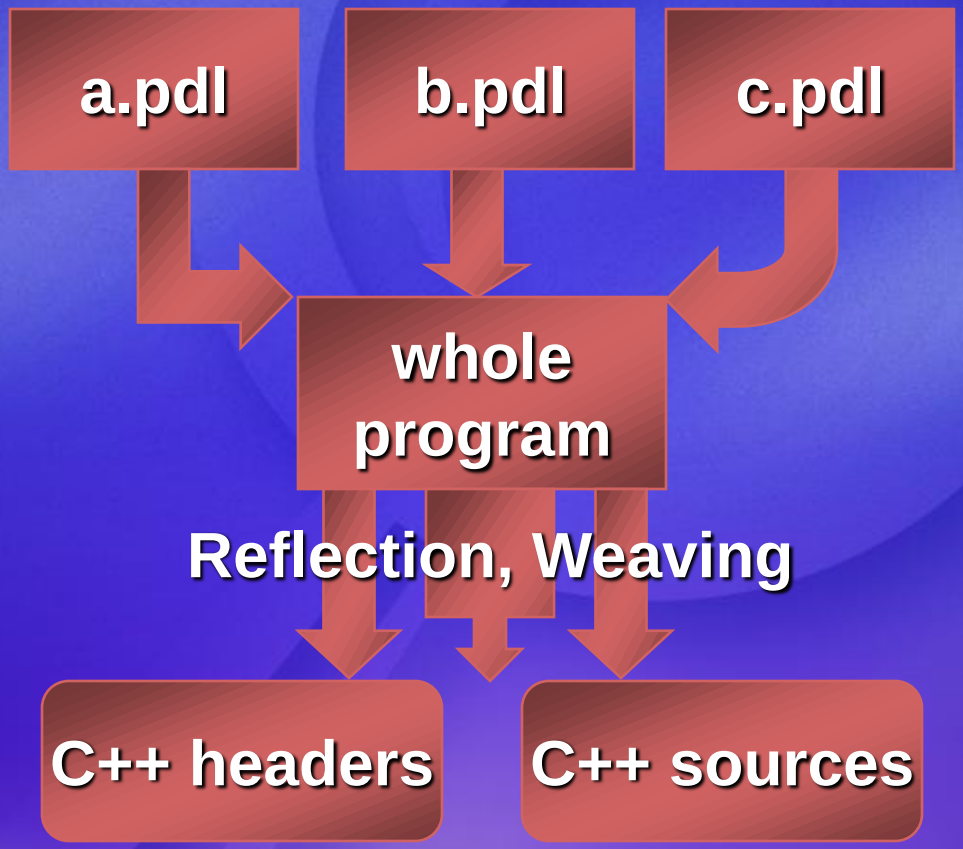
PDL is a C++/CLI-like language for headers. It evolved from a solution for dual-mode C++ compilation to much more.

Interesting Features:

- Metaprogramming attributes on objects and members
- Partial classes
- Weaving
- Bitpacking
- Dual Mode

We'll look further into the green ones.

PDL to C++



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PHOENIX
CodeGen . Optimization . Analysis

PDL - Attributes

- Class
  - Layout
  - Align
  - Extensible
  - FreeList
  - Cloneable
  - Dynamic
  - Visit
  - Kind
- Element
  - Sealed
  - Thunk
  - NoZeroInit
  - NoReinit
  - Ordered
  - List
  - NoClone
  - Owner
  - Context
  - CustomFixup

Example: Rectangle

```
public ref class Rectangle
  : public class Object
{
public:
    int HorizontalLength;
    int VerticalLength;
};
```

Rectangle: Visitor Weaving

```
[visit]
public ref class Rectangle;

// Auto-generated
void Rectangle::Accept(Visitor ^ visitor)
{
    visitor->Visit(this);
}

void Visitor::Visit(Rectangle ^ rectangle)
{
    // Default method: Do nothing or throw
}
```

Visitor Pattern

- Good
  - Decouple unwanted/unpredicted concerns from basic classes.
  - Implement distributed algorithm in one place.
  - Visitor hierarchy good way to provide small variations on an algorithm.
- Bad
  - Not extensible cross-assembly.
  - Must maintain visitors when adding new classes or fields.

Rectangle: Cloning Visitor

```
[visit, cloneable]
public ref class Rectangle;

// Auto-generated
void CloneVisitor::Visit(Rectangle ^ rect)
{
    if (Map[rect] != NULL) {
        Result = Map[rect];
    } else {
        Rectangle ^ newRect = gcnew Rectangle;
        newRect->HorizontalLength =
            rect->HorizontalLength;
        newRect->VerticalLength = rect->VerticalLength;
        Result = Map[rect] = newRect;
    }
}
```

Rectangle: Class Updates

```
[visit, cloneable]
public ref class Rectangle
  : public class Object
{
public:
    Color Shade;
    int HorizontalLength;
    int VerticalLength;
};

// Clone Visitor automatically
// updates
```

Rectangle: Cloning Issues

```
[visit, cloneable]
public ref class Rectangle
  : public class Object
{
public:
    Color Shade;
    int HorizontalLength;
    int VerticalLength;
    // What to do?
    CartesianGrid ^ Grid;
    Coordinate Position;
};
```

Rectangle: Cloning Issues

```
[visit, cloneable]
public ref class Rectangle
  : public class Object
{
public:
    Color Shade;
    int HorizontalLength;
    int VerticalLength;
    // Try 1
    [NoClone] CartesianGrid ^ Grid;
    [NoClone]
    Coordinate GridPosition;
};
```

Rectangle: Cloning Issues

```
[visit, cloneable]
public ref class Rectangle
  : public class Object
{
public:
    Color Shade;
    int HorizontalLength;
    int VerticalLength;
    // Try 2
    [Clone(Owner)] CartesianGrid ^ Grid;
    [Clone(Context="Grid")]
    Coordinate GridPosition;
 };
```

Example: Cloning Phoenix's Intermediate Representation

An Operand might be cloned

- By itself
- As part of an instruction
- As part of a Function

The more context, the more is cloned. "Context" attribute helped share code, and neatly encapsulated a lot of complex logic

Compile-time reflection

- Used to generate object walker
- Walker useful for any algorithms that need to walk all or most of objects' fields.
  - Cloning
  - Serialization/deserialization
  - Comparison
  - Diagnostic Dumper

Phoenix Links

- Early access RDKs or CDKs available to selected universities or commercial partners; sample projects include AOP, Obfuscation, and Profiling
- Contact phxap@microsoft.com for Academic early access requests, or phxcp@microsoft.com for Commercial early access requests. No NDA must be signed.
- Or see http://research.microsoft.com/phoenix
- Come to the Phoenix discussion on Tuesday!