LIFE WITH OPAQUE POINTERS FROM A FRONTEND PERSPECTIVE

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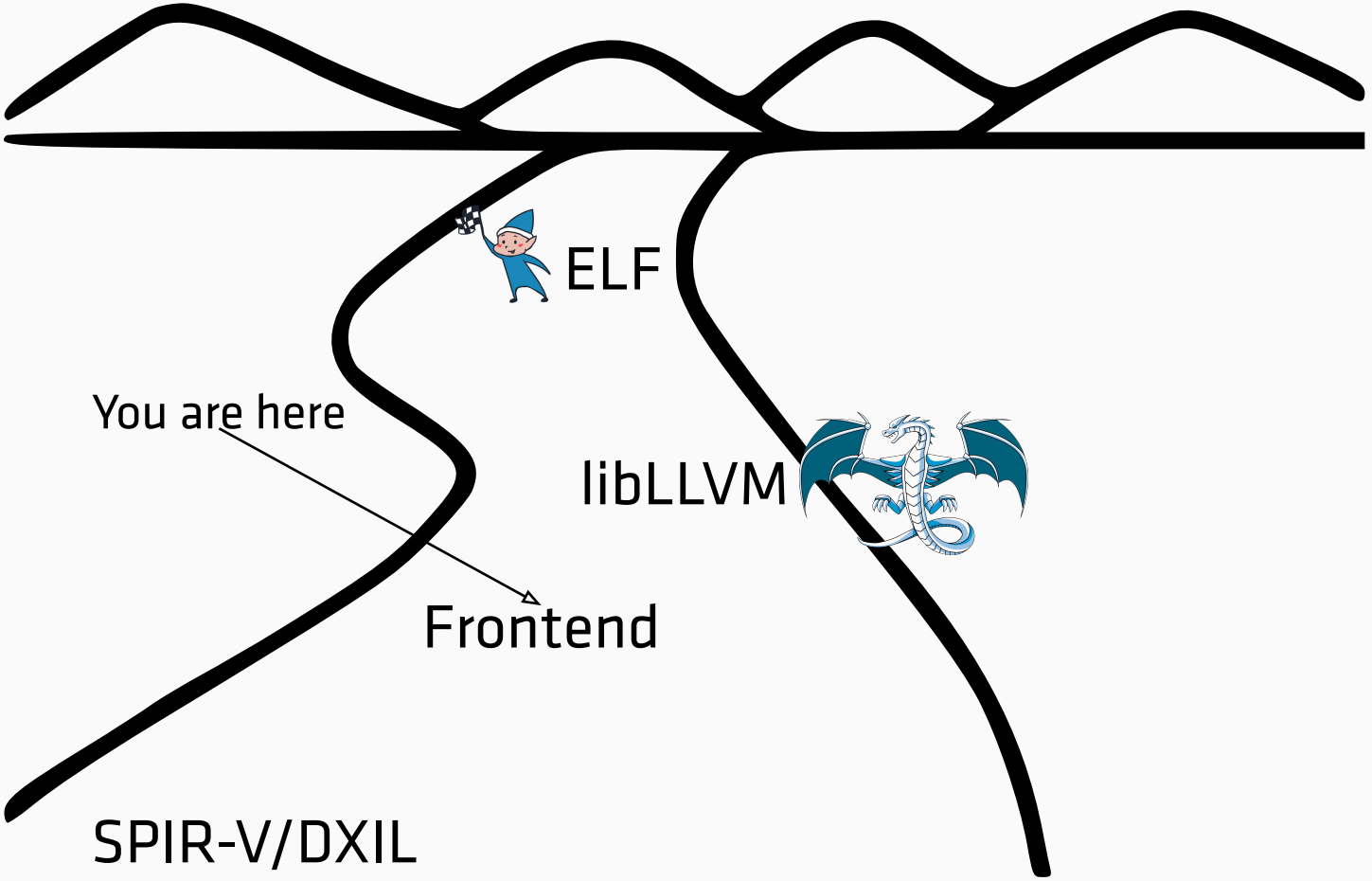
AMD

together we advance_

OVERVIEW

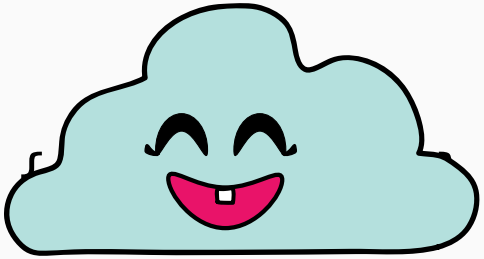


PROBLEM

```
{ i32, float } *
```

```
getPointerElementType
```

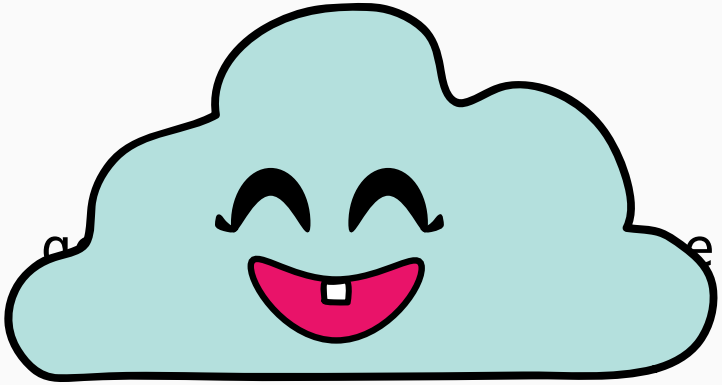
PROBLEM



*

Memory is untyped

⚡ Attack of Opaque Pointers



→ ???

CHANGES (GENERAL)

getPointerElementType

```
getValueType           // GlobalValue
getAllocatedType       // AllocaInst
getResultElementType   // GetElementPtrInst
…
```

```
Value *allocVal();
Value *createVal();
define void @func([10 x i32]* %arg)
getPointerElementType
```

```
AllocaInst *allocVal();
std::pair<Value *, Type *> createVal();
define void @func([10 x i32] %arg)
DenseMap<Value *, Type *> ElementTypes
```

CHANGES (SPIR-V)

Problem:

Type `[10 x i32]` has no semantic meaning

```
getelementptr [10 x i32],
              ptr %arr,
              i32 0,
              i32 5
```

Goal:

Want to know stride in later pass

Solution:

Use custom “intrinsic” to preserve array stride

```
call ptr @array.gep(ptr %arr,
                    /* stride */ i32 4,
                    /* index */ i32 5)
```

This slide is brought to you by `llvm-dialects`

CHANGES (DXIL)

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DirectX 12 ULTIMATE

What is DXIL?

- Bitcode from ~LLVM 3.7

Example

```
type %struct.Payload = { i32, float }
void @shader(%struct.Payload* %payload) {}
```

CHANGES (DXIL)

DirectX XII ULTIMATE

What is DXIL?

- Bitcode from ~LLVM 3.7

Example

```
type %struct.Payload = { i32, float }
void @shader(%struct.Payload* %payload) {}
```

⚡ Attack of Opaque Pointers (+ Bitcode auto-upgrader)

```
void @shader(ptr %payload) {}
```

Problem:

Need type information from signatures

```
void @shader(ptr %payload) {}
```

Solution:

`BitcodeReader` hook saves types in metadata

```
type %struct.Payload = { i32, float }
void @shader(ptr %payload) !types !0 {}
!0 = !{%struct.Payload poison}
```

Problem:

Need type information from signatures

```
void @shader(ptr %payload) {}
```

Solution:

`BitcodeReader` hook saves types in metadata

```
type %struct.Payload = { i32, float }
void @shader(ptr %payload) !types !0 {}
!0 = !{%struct.Payload poison}
```

In C++:

```
shader->getArgOperand(0)
      ->getType()
      ->getPointerElementType()
```

```
cast<ConstantAsMetadata>(
  shader->getMetadata("types")
        ->getOperand(0))
  ->getType()
```

Implementation in `unittests/Bitcode/BitReaderTest.cpp`

SUMMARY

- Change function signatures and pass arguments by value
- Use intrinsics to preserve information
- `BitcodeReader` hook to save argument types in metadata
- **Tip**: Support opaque and typed pointers at the same time to easily switch back on regressions

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