GLSL Support in Mesa

Current state

- What parts are good
- What parts are not so good
- What parts are *really* miserable

Where we want to be

- What is the ideal world

How we're getting there

- Work being done now
- Work being done later

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Good

Many shaders work on real hardware

- We're shipping on i915 and i965 for some time

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Good

Language extensions allow many language intrinsics to be written in GLSL

- `__constructor` allows constructor functions
- `__operator` allows operator overloading to decompose complex operators (i.e., matrix multiplications) into simpler operations
  - Dramatically simplifies type checking
- `__asm` allows in-line assembly to implement operators
  - Here assembly means `ARB_fragment_program`

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Not So Good

- Assumes only hardware type is `vec4`
  - Each integer operation is converted to a floating point operation followed by a rounding operation *very* early
- Language intrinsics are recompiled at run-time
  - Tokenized off-line
- Missing some GLSL 1.20 language features
  - GLSL 1.30 support not even started

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Really Bad

One-off parser generator

- Parser generator code isn't in main source tree

Linker can't support multiple compilation units on the same shader target

- Various other bugs related to this missing feature

`ARB_fragment_program` is the IR

- Really bad fit for lots of real hardware

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Infrastructure We Want

Sensible parser infrastructure

- Allow others fix bugs or add language features

Back-end independent IR

- Most real hardware doesn't look much like `ARB_fragment_program`
- DirectX uses our current approach for HLSL, and drivers have to de-compile and recompile the assembly...fail

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Language Features We Want

A compliant linker

- Multiple compilation units at each shader target has been a *required* feature since day-1

Real integer support

- Allow hardware with real integers to use them

Full GLSL 1.20 and 1.30 support

- Unsigned integers and integer bit twiddling
- `switch`-statements

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Work Being Done Now

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GLSL work being done for the last month or so...around various travel

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Parser Infrastructure

Parser re-written using flex and bison

- All 1.20 core language features supported
- Preprocessor still to be implemented
- Generates a tree-based AST that looks a *lot* like what GCC uses

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Back-End Independent IR

AST is converted to middle-level intermediate representation (MIR)

- Work-in-progress
- Encodes a reduced subset of language features
  - “Flattened” expressions, `for`-loops, `if`-statements

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Back-End Independent IR

MIR is translated to existing IR

- Work-in-progress...mostly hand-waving at this point
- Possible to generate hardware instructions directly from MIR without ever touching existing IR

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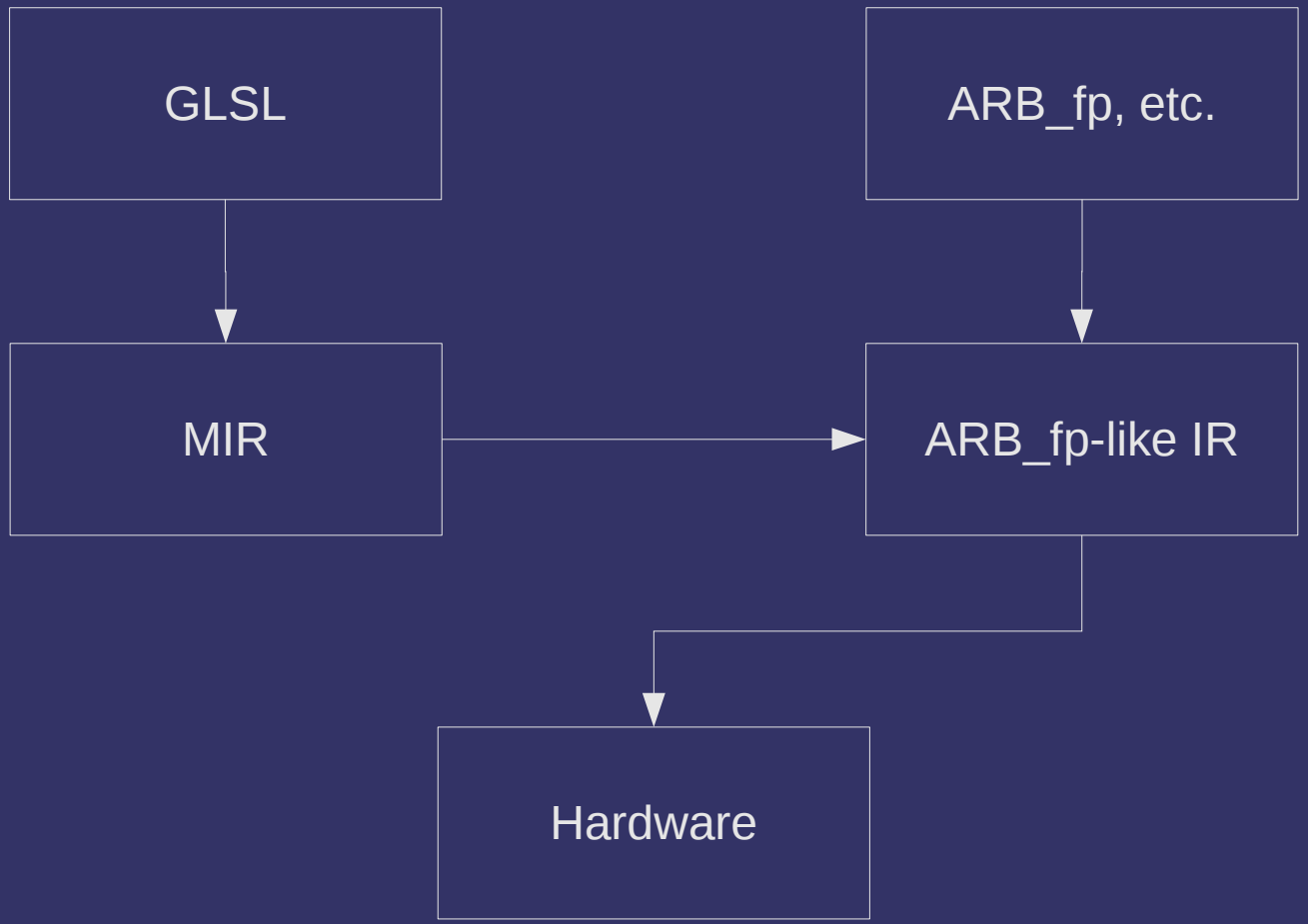
Back-End Independent IR



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Back-End Independent IR

Language intrinsics compiled to MIR off-line

- Fake link-phase combines intrinsic MIR to translation unit being compiled

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C*Compliant Linker*

Linker operates on MIR

- Code is generation happens *after* linking
- Additional in-lining, constant propagation, etc. occurs after linking

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Work Not Being Done Now

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GLSL infrastructure work will continue on into next year...at least

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GLSL 1.30

Some new language features aren't being implemented yet

- New integer operators (e.g. bit twiddling)
- `switch`-statements

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Additional Shader Stages

Geometry shaders not yet supported

- Additional shader stages may be added soon, these aren't supported yet either

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Code-Generator Generator

Real multiple-target compilers use code-generator generators

- Don't want to generate machine code from existing low-level IR...it's a bad fit for most hardware
- Hand-writing code generators is tedious

Assembly Shaders to MIR

Support for additional assembly extensions

- Direct implementation is not a good fit on some hardware
- Some apps (e.g. those that use Cg) *prefer* to use assembly shaders
- `GL_NV_vertex_program3` on R500 hardware *for free* feels like winning

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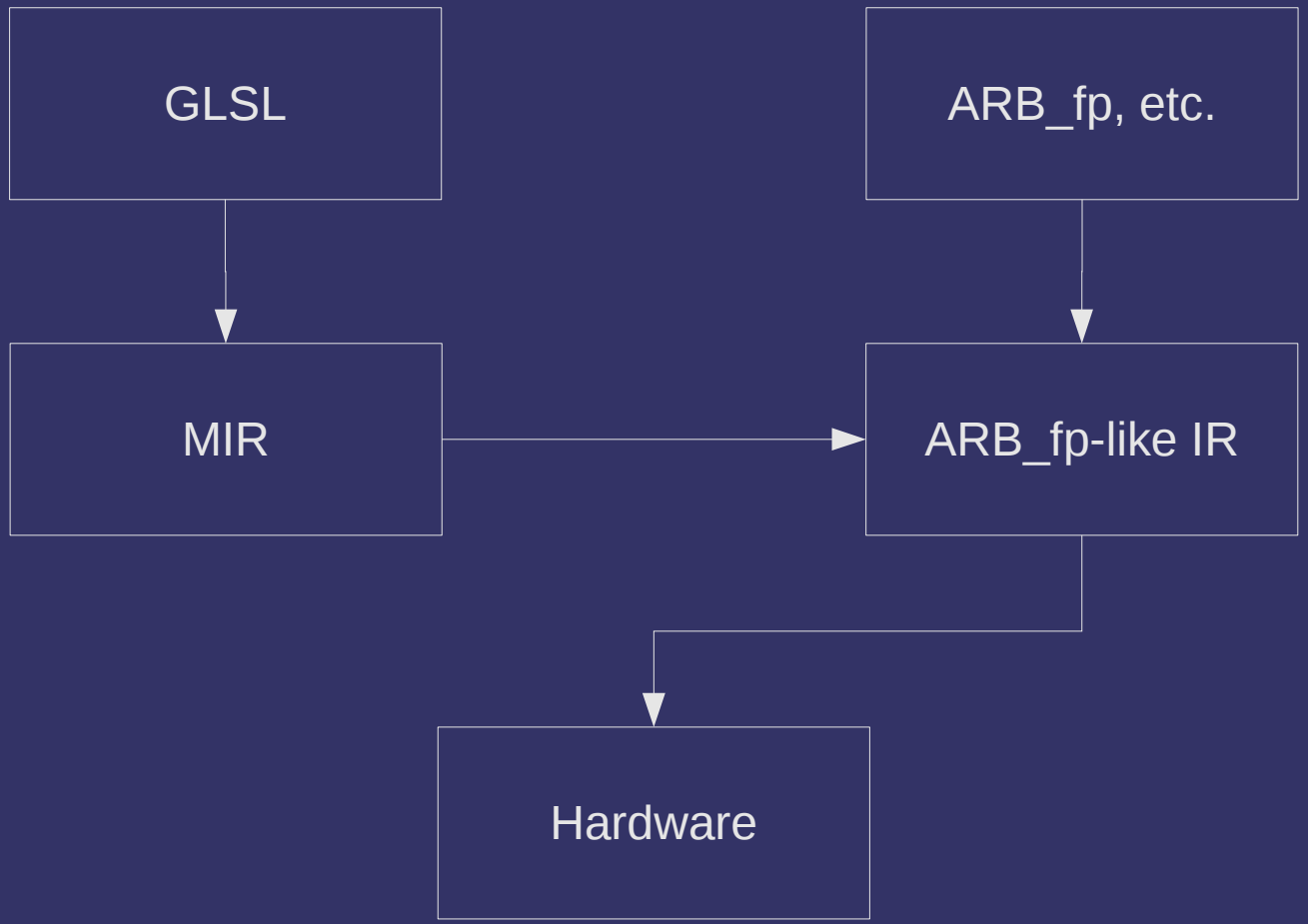
Assembly Shaders to MIR



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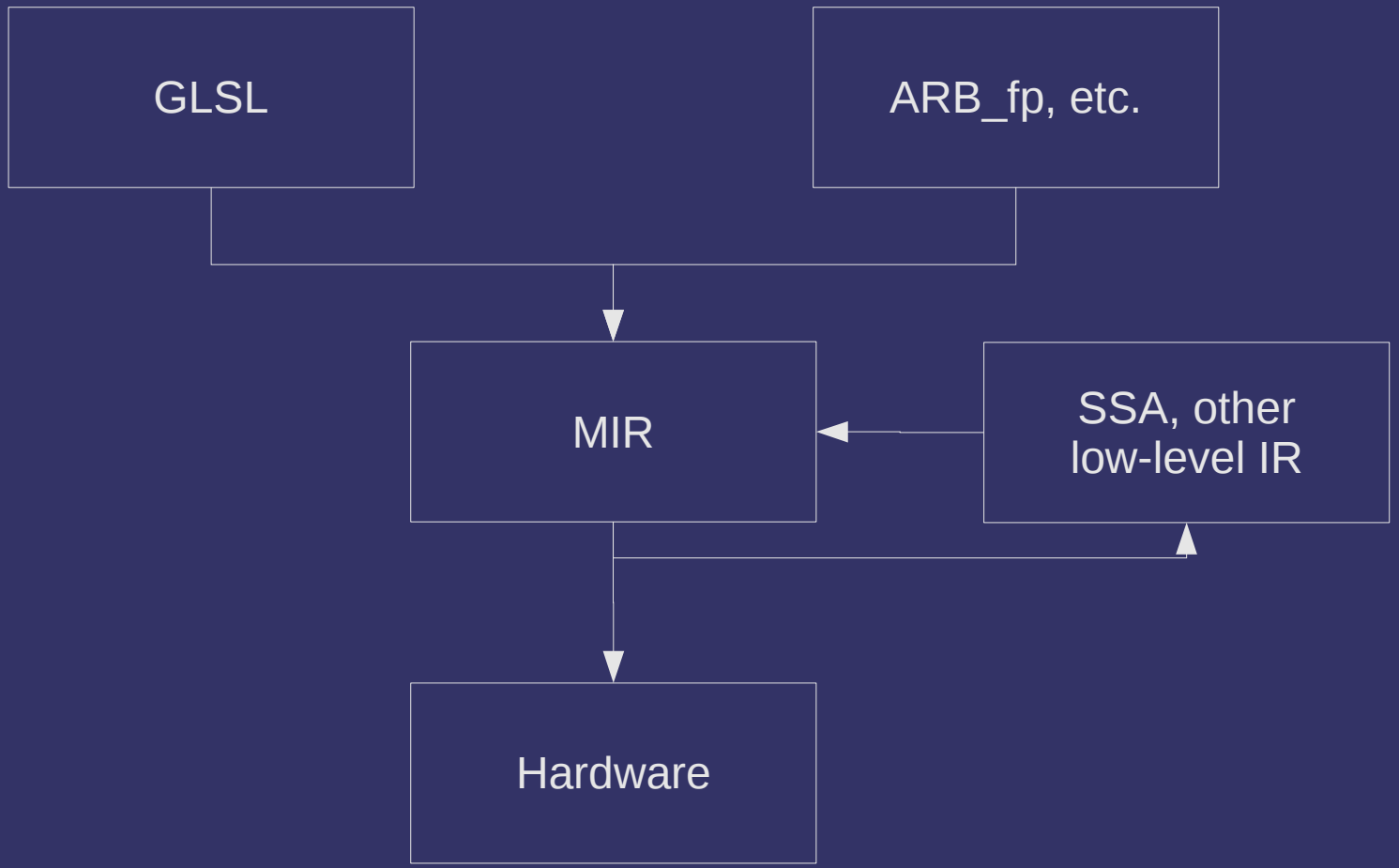
Assembly Shaders to MIR



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Fin

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