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Outline

- Mason Improvements
- Bash Tab Completion For chpl
- Compiler Flag Suggestions
- Default Executable Name Change
- LLVM Back-end Improvements
- Communication Optimization with --llvm-wide-opt
- Other Compiler/Tool Improvements
Mason Improvements
Mason: Background

● Mason is the Chapel package manager
  ● Supports commands for completing different tasks
    new Create a new mason project
    update Update/Generate Mason.lock
    build Compile the current project
    run Build and execute src/<project name>.chpl
    search Search the registry for packages
    env Print environment variables recognized by mason
    clean Remove the target directory
    doc Build this project's documentation

● Uses a registry containing “Bricks” describing packages
  ● Default registry is publicly hosted at github.com/chapel-lang/mason-registry
  ● MASON_REGISTRY environment variable overrides the default location
  ● Only one registry can be used at a time
Mason: This Effort

- **Added support for multiple mason registries**
  - MASON_REGISTRY is now a comma separated list of registries
  - Each registry has an optional “name|” prefix to name a local directory to use
  - “name” defaults to the text following the final slash in the location
    ```
    export MASON_REGISTRY="loc|/path/to/reg1,http://reg2.com/reg"
    ```

- **Added two new mason commands**
  - `help` Display a help message
  - `version` Display the mason version number

- **Added “make install” support**
  - After building mason it can be installed next to the “chpl” binary
Mason: Impact

● Mason can now use multiple registries
  ● Bricks are searched for in left-to-right order of MASON_REGISTRY
  ● Registries can be local and include local, private packages
  ● Each registry can be named locally using MASON_REGISTRY

● Mason can easily be installed next to the chpl binary
  make install

● Show help/version messages with mason commands
  mason help
  mason version
Mason: Next Steps

Next Steps: Continue to add and harden Mason features

- Add mason commands for additional functions
  - `add` add a dependency
  - `rm` remove a dependency
  - `init` create a project in an existing directory
  - `test` run project tests
  - ...

- Add support for C dependencies
- Simplify creation of registries and adding new Bricks
- Improve error messages
- Add continuous integration testing for the package ecosystem
Bash Tab-completion for chpl
Tab-completion for chpl

Background: There are many verbosely-named chpl options
● Finding the right option requires searching help output or man pages
  chpl --help
  man chpl

This Effort: Add a bash tab-completion script for chpl
● Script knows about all compiler options and can autocomplete them
● For multiple matches, prints them and completes as much as possible

Impact: Bash users can autocomplete chpl options
● Bash users can use tab-completion for chpl compiler options
  source $CHPL_HOME/util/chpl-completion.bash

Next steps: Developer vs. non-developer options
● Only autocomplete developer options when in developer mode
Compiler Flag Suggestions
Flag Suggestions

**Background:** Compiler gave a generic error for misspelled flags

```bash
$ chpl -fast
Unrecognized flag: '-f' (use '-h' for help)
$ chpl --ieee
Unrecognized flag: '--ieee' (use '-h' for help)
```

**This Effort:** Compiler suggests a flag in simple cases

```bash
$ chpl -fast
Unrecognized flag: '-f' (use '-h' for help)
   Did you mean --fast ?
$ chpl --ieee
Unrecognized flag: '--ieee' (use '-h' for help)
   Did you mean --ieee-float ?
```

**Impact:** Compiler is more friendly
Default Executable Name Change
Executable Name: Background

Background:

- Historically, compiling `foo.chpl` resulted in the executable `a.out`
- In 1.16, executable started being named after the main module
  - Why?
    - because every program has a single main module (vs. multiple files and modules)
    - because in practice the main module typically takes its name from its file

- However, this led to confusion in certain cases:

```chapl
module M1 {
    writeln("Hello!");
}
```

```
> chpl myProgram.chpl
> ./myProgram
./myProgram: No such file or directory
```

- Users are accustomed to executables taking the name of some file
Executable Name: This Effort and Impact

This Effort:
- 1.17 names the executable after the file containing the main module
  - Why?
    - still uses something unique about the program
    - avoids the surprising cases that 1.16 had
    - returns to normal situation of naming executables after files
    - still supports the common case of the main module taking its name from its file

Impact:

myProgram.chpl:
```chpl
module M1 {
  writeln(“Hello!”);
}
```

> chpl myProgram.chpl
> ./myProgram
Hello!
LLVM Back-end Improvements
LLVM Back-end Improvements: Background

● LLVM is a compiler optimization framework
  ● actively developed and constantly improving

● We want LLVM to become our default back end
  ● to focus our attention instead of dividing it among C compilers
  ● to improve optimization
  ● to enable communication optimization
LLVM Back-end Improvements: This Effort

- Ported Chapel to LLVM 6.0
- Removed support for LLVM versions older than 4.0
- CHPL_LLVM=system now supports Mac Homebrew
- Improved precision of LLVM alias analysis metadata
- Improved --llvm compilation speed
- Addressed problems with --llvm-wide-opt
  - See: next section
LLVM: Impact: Compilation Time

- LLVM compilation time has improved
- now competitive with C backend
LLVM: Impact: Performance

- LLVM performance has improved with LLVM 6
LLVM Back-end Improvements

**Impact:**
- LLVM 6.0 vectorizes more cases when llvm-wide-opt is used
- code kept maintainable by removing obsolete version support
- users and developers can start quickly with CHPL_LLVM=system

**Status:**
- --llvm and --llvm-wide-opt are tested nightly
- performance is improving and generally competitive with C backend
  - occasionally beating C compilers

**Next Steps:**
- continue to push towards using --llvm by default
- port Chapel’s LLVM interface to ARM
  - match ABI characteristics that differ from x86-64
Communication Optimization with --llvm-wide-opt
Comm Opt: Background

- Idea is to use LLVM passes to optimize GET and PUT
- Enabled with --llvm-wide-opt compiler flag
- First appeared in Chapel 1.8
- Unfortunately was not working in 1.15 and 1.16 releases
Comm Opt: in a Picture

// x is possibly remote
var sum = 0;
for i in 1..100 {
    %l = get(x);
    sum += %l;
}

var sum = 0;
for i in 1..100 {
    %l = get(x);
    sum += %l;
}

TO GLOBAL MEMORY

var sum = 0;
for i in 1..100 {
    %l = load <100> %x
    sum += %l;
}

TO DISTRIBUTED MEMORY

var sum = 0;
for i in 1..100 {
    %l = load <100> %x
    sum += %l;
}

EXISTING LLVM OPTIMIZATION
LICM

load <100> %x = load i64 addrspace(100)* %x
Comm Opt: Details

- Uses existing LLVM passes to optimize GET and PUT
  - GET/PUT represented as load/store with special pointer type
  - normal LLVM optimizations run and optimize load/store as usual
  - an LLVM pass lowers them back to calls to the Chapel runtime

- Optimization gains from this strategy can be significant
  - See "LLVM-based Communication Optimizations for PGAS Programs"

- Historically, needed packed wide pointers as workaround
  - wide pointer normally stored as a 128-bit struct: {node id, address}
  - bugs in LLVM prevented using 128-bit pointers
  - packed wide pointers store node id in high bits of a 64-bit address
  - led to scalability constraints — maximum of 65536 nodes
  - sometimes made --llvm-wide-opt code slower than C backend
Comm Opt: This Effort, Impact

This Effort: Fix --llvm-wide-opt for 1.17
- remove packed wide pointer workaround
- remove CHPL_WIDE_POINTERS configuration variable
- resolve other bugs, including 2 bugs in LLVM itself
- perform initial performance study

Impact: --llvm-wide-opt is much closer to production quality
- Design now supports more than 100,000 nodes
- Overhead is reduced
- No longer reduces performance relative to the C backend
- Significant performance improvement for some benchmarks
Comm Opt: Impact

Speedup of --llvm and --llvm-wide-opt vs C on 16 nodes XC

Times Faster

HPCC PTRANS  NPB EP  miniMD  HPCC HPL  HPCC FFT  NPB MG  Lulesh  CoMD

C  llvm  llvm-wide-opt
Comm Opt: Next Steps

- Perform more testing
- Contribute bug fixes for 128-bit pointers upstream
- Enable --llvm-wide-opt by default with --fast
- Reduce compile time spent in this optimization
Other Compiler/Tool Improvements
Other Compiler/Tool Improvements

- Extern blocks now support `#defines with casted literals`
- Rewrote and improved the `printchplenv` tool
- Rewrote and improved the `compileline` tool
- Added error handling constructs to syntax highlighters
- Added `prototype` modules to syntax highlighters
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