Compiler Improvements

Chapel Team, Cray Inc.
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Outline

- Controlling / Exposing Chapel’s Configuration
- Complex Type Improvements via C99 Complex
- Other Compiler Improvements

Controlling / Exposing Chapel's Configuration

Chapel Configuration: Background

Background:

- Chapel's configuration specified by ~23 environment variables
  - CHPL_HOME, CHPL_COMM, CHPL_MEM, CHPL_TASKS, …

- Changing configurations required changing env. vars:

```
export CHPL_COMM=none
chpl foo.chpl -o foo-shared
export CHPL_COMM=gasnet
chpl foo.chpl -o foo-dist
```

- Built-in CHPL_* params have permitted Chapel code to access config.
  - yet never documented with chpldoc

Chapel Configuration: This Effort

- **Added compiler flags for specifying configuration**

```
--home, --comm, --mem, --tasks, …
```

  - Backed by existing CHPL_* environment variables
    - more consistent with other compiler flags
  - Simplifies ability to switch between configurations:

```
chpl --comm=none   foo.chpl -o foo-shared
chpl --comm=gasnet foo.chpl -o foo-dist
```

  - Flags documented in man page and `chpl --help` output

- **Refactored params into their own (internal) module**
  - Location:

```
modules/internal/ChapelEnv.chpl
```

  - Documented with chpldoc, accessible in online documentation: http://chapel.cray.com/docs/1.13/modules/internal/ChapelEnv.html

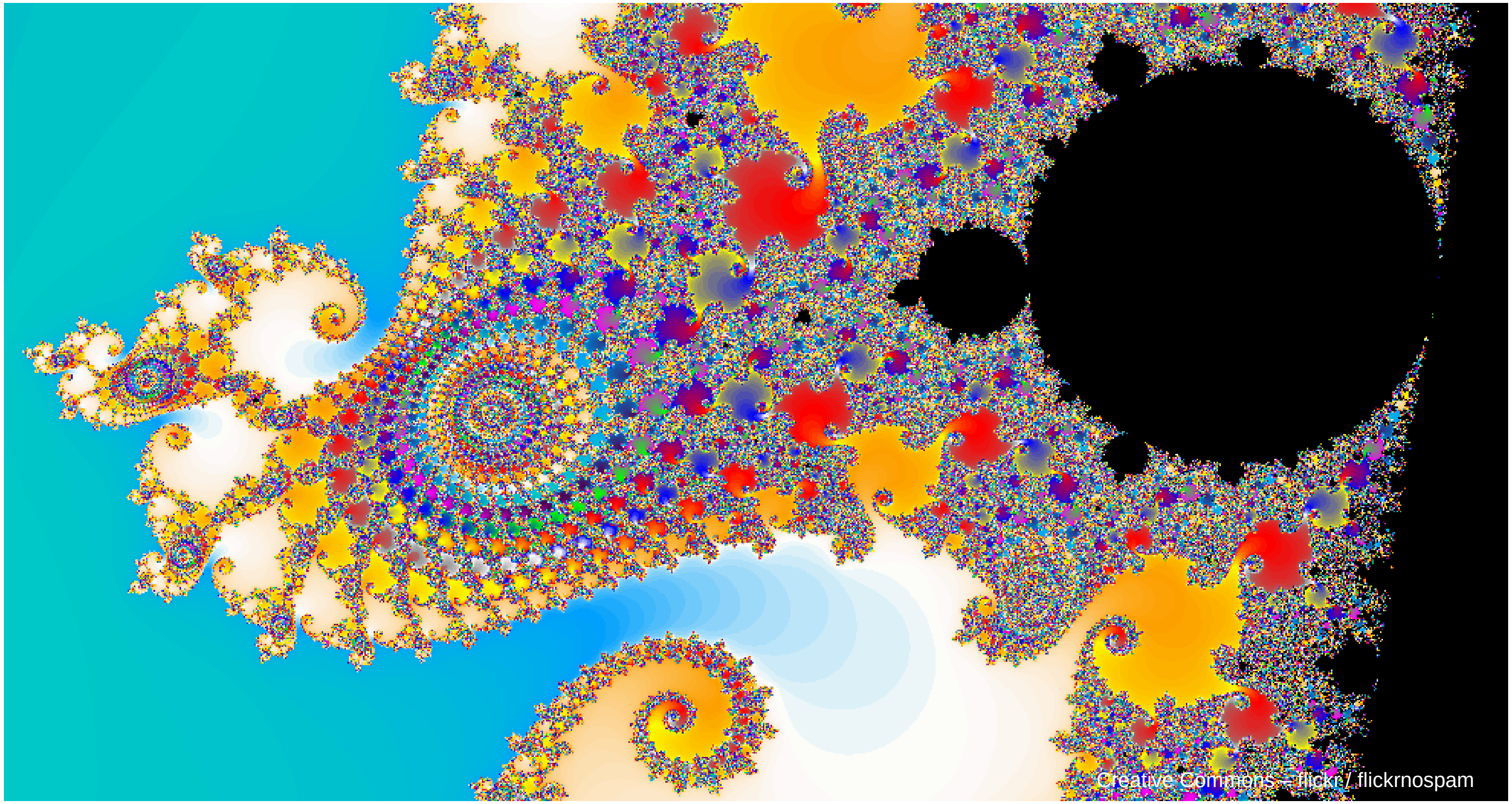
Chapel Configuration: Next Steps

- **.chplrc file**
  - Add ability to specify default Chapel configuration / compilation flags
  - Will benefit package-based deployment and system-wide installations
  - Will simplify managing multiple configurations
- **Rename ChapelEnv.chpl and reword documentation**
  - Name/text reflects historical nature: environment variable-centric

Complex Type Improvements via C99 Complex

Complex Types: Background

- **Complex types were implemented as homegrown records**
  - Stored two *real* valued components
  - Performed math operations on the individual components



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Complex Types: This Effort

- **Replace our homegrown records with C99 complex types**
  - Generate cleaner code
  - Generate safer floating point code

- **Give back-end compiler more complete type information**

- **Simplify the compiler implementation**
  - Removed complexToRecord pass

- **Simplify interoperability with C libraries**

Complex Types: Impact

- Improved generated code involving complex types

```
proc f(a: complex, b: complex, c: complex) {
  return a * b / c;
}
```

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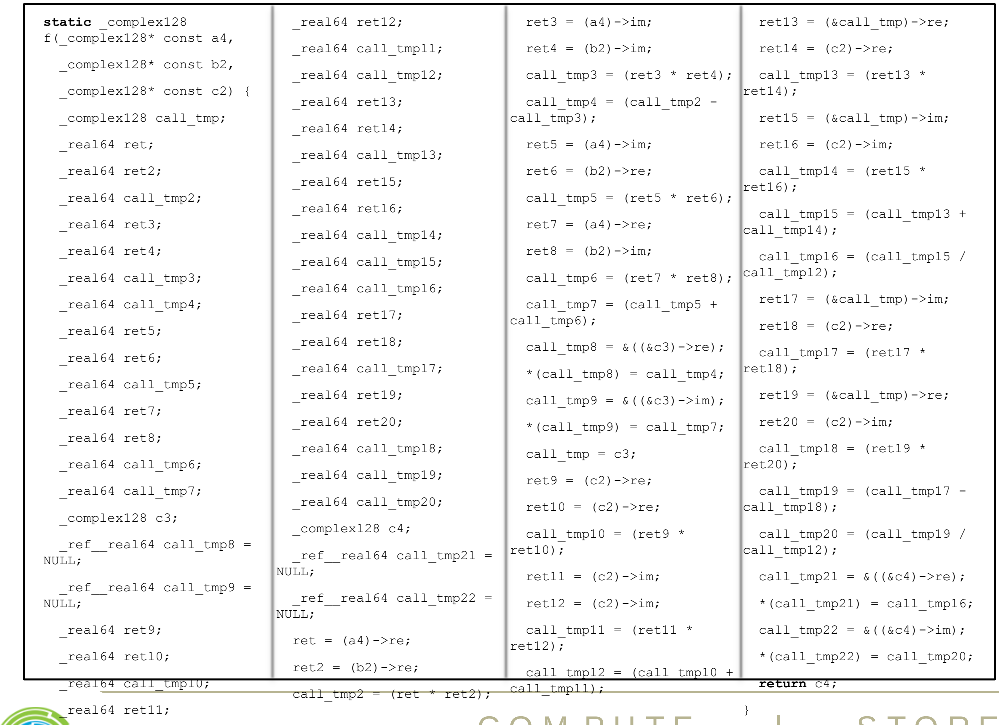

```
static _complex128
f(_complex128* const a4,
  _complex128* const b2,
  _complex128* const c2) {
  _complex128 call_tmp;
  _real64 ret;
  _real64 ret2;
  _real64 call_tmp2;
  _real64 ret3;
  _real64 ret4;
  _real64 call_tmp3;
  _real64 call_tmp4;
  _real64 ret5;
  _real64 ret6;
  _real64 call_tmp5;
  _real64 ret7;
  _real64 ret8;
  _real64 call_tmp6;
  _real64 call_tmp7;
  _complex128 c3;
  _ref__real64 call_tmp8 =
NULL;
  _ref__real64 call_tmp9 =
NULL;
  _real64 ret9;
  _real64 ret10;
  _real64 call_tmp10;
  _real64 ret11;
  _real64 ret12;
  _real64 call_tmp11;
  _real64 call_tmp12;
  _real64 ret13;
  _real64 ret14;
  _real64 call_tmp13;
  _real64 ret15;
  _real64 ret16;
  _real64 call_tmp14;
  _real64 call_tmp15;
  _real64 call_tmp16;
  _real64 ret17;
  _real64 ret18;
  _real64 call_tmp17;
  _real64 ret19;
  _real64 ret20;
  _real64 call_tmp18;
  _real64 call_tmp19;
  _real64 call_tmp20;
  _complex128 c4;
  _ref__real64 call_tmp21 =
NULL;
  _ref__real64 call_tmp22 =
NULL;
  ret = (a4)->re;
  ret2 = (b2)->re;
  call_tmp2 = (ret * ret2);
  ret3 = (a4)->im;
  ret4 = (b2)->im;
  call_tmp3 = (ret3 * ret4);
  call_tmp4 = (call_tmp2 -
call_tmp3);
  ret5 = (a4)->im;
  ret6 = (b2)->re;
  call_tmp5 = (ret5 * ret6);
  ret7 = (a4)->re;
  ret8 = (b2)->im;
  call_tmp6 = (ret7 * ret8);
  call_tmp7 = (call_tmp5 +
call_tmp6);
  call_tmp8 = &((&c3)->re);
  *(call_tmp8) = call_tmp4;
  call_tmp9 = &((&c3)->im);
  *(call_tmp9) = call_tmp7;
  call_tmp = c3;
  ret9 = (c2)->re;
  ret10 = (c2)->re;
  call_tmp10 = (ret9 *
ret10);
  ret11 = (c2)->im;
  ret12 = (c2)->im;
  call_tmp11 = (ret11 *
ret12);
  call_tmp12 = (call_tmp10 +
call_tmp11);
  ret13 = (&call_tmp)->re;
  ret14 = (c2)->re;
  call_tmp13 = (ret13 *
ret14);
  ret15 = (&call_tmp)->im;
  ret16 = (c2)->im;
  call_tmp14 = (ret15 *
ret16);
  call_tmp15 = (call_tmp13 +
call_tmp14);
  call_tmp16 = (call_tmp15 /
call_tmp12);
  ret17 = (&call_tmp)->im;
  ret18 = (c2)->re;
  call_tmp17 = (ret17 *
ret18);
  ret19 = (&call_tmp)->re;
  ret20 = (c2)->im;
  call_tmp18 = (ret19 *
ret20);
  call_tmp19 = (call_tmp17 -
call_tmp18);
  call_tmp20 = (call_tmp19 /
call_tmp12);
  call_tmp21 = &((&c4)->re);
  *(call_tmp21) = call_tmp16;
  call_tmp22 = &((&c4)->im);
  *(call_tmp22) = call_tmp20;
  return c4;
}
```

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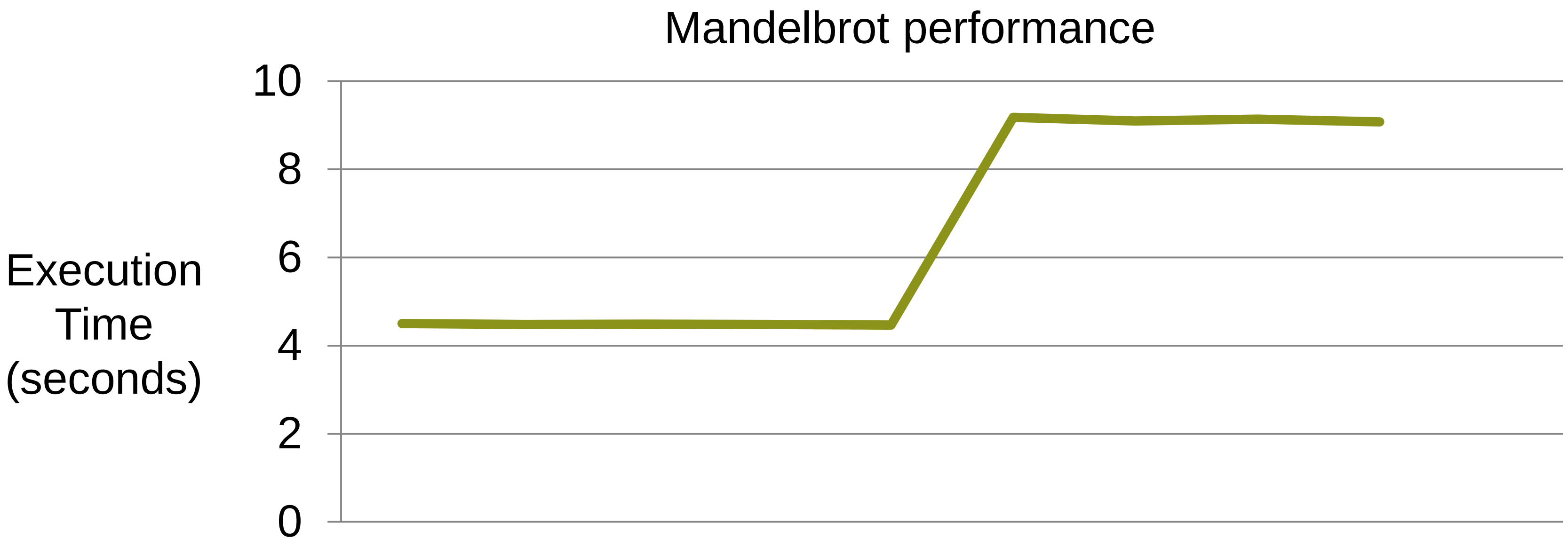
```
static _complex128 f(_complex128 a4,
                     _complex128 b2,
                     _complex128 c2) {
  _complex128 call_tmp;
  _complex128 call_tmp2;
  call_tmp = (a4 * b2);
  call_tmp2 = (call_tmp / c2);
  return call_tmp2;
}
```

Complex Types: Performance-Safety Tradeoff



- **Caused by back-end multiply and divide implementation**
  - Safer for “weird” floating point values, but slower overall
    - NaNs
    - Infinities
    - Denormalized
- **Compile with ‘--no-ieee-floats’ to regain the performance**

Other Compiler Improvements

Other Compiler Improvements

- **enum config values can now be fully qualified**
  (contributed by Nick Park)
  - supports,

    ```
    ./a.out --fillColor=color.red
    ```

  - whereas previously, one had to use:

    ```
    ./a.out --fillColor=red
    ```

- **the --ldflags flag now “stacks” when several are used**
- **the --no-warnings flag can now be reversed via --warnings**
- **improved filename representation in generated code**
  - switched from string literals to a table of filenames + indices into it
- **also:**
  - many performance improvements (covered elsewhere)
  - many developer-oriented improvements (see CHANGES.md)

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