Chapel: Compiler Overview

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Outline

- Chapel Compiler System Overview
- Version 0.9 Release and Status

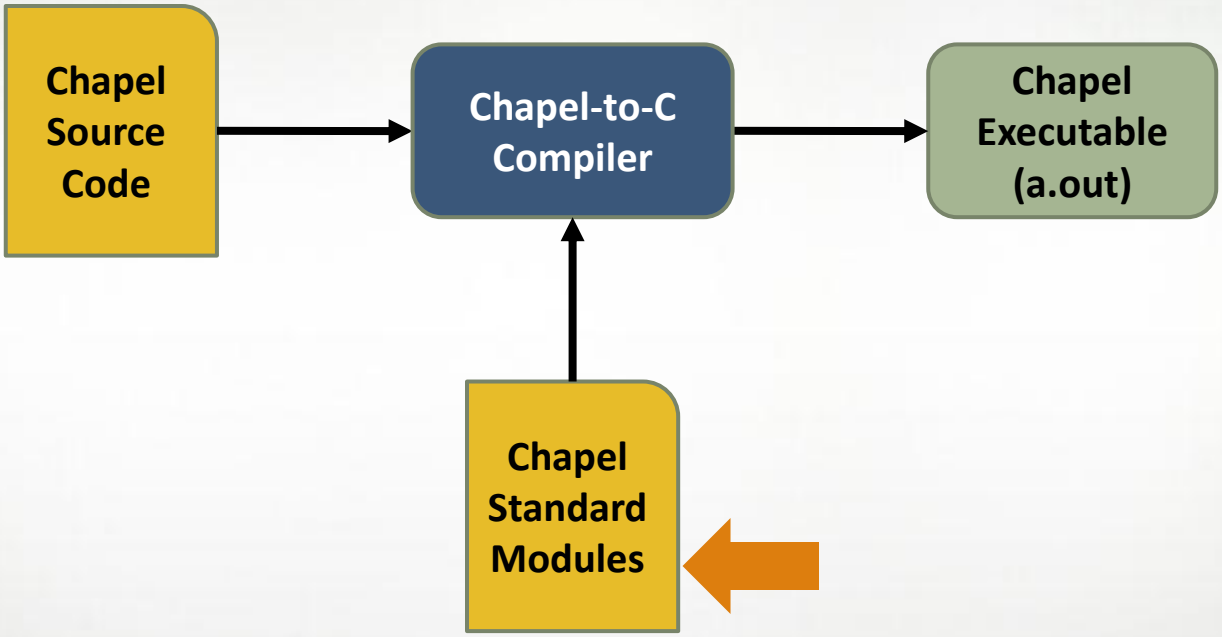
Prototype Compiler Development Strategy

- Start development within Cray under HPCS
- Initial releases to select users
- First public release November 2008
- Second public release April 2009
  - Migrated to SourceForge
  - Major step in opening development
- Turn over to community when ready

Prototype Compilation Approach

- Chapel-to-C compiler for portability
  - C++ compiler generates strict C code
  - Tested against GCC and several vendor's compilers
- Link against threading and communication libraries
  - Default threading layer on most platforms: pThreads
  - Default communication layer on most platforms: GASNet
- Use many standard and internal Chapel modules

Compiler Schematic



Chapel Standard Modules

Standard modules implement standard library routines.

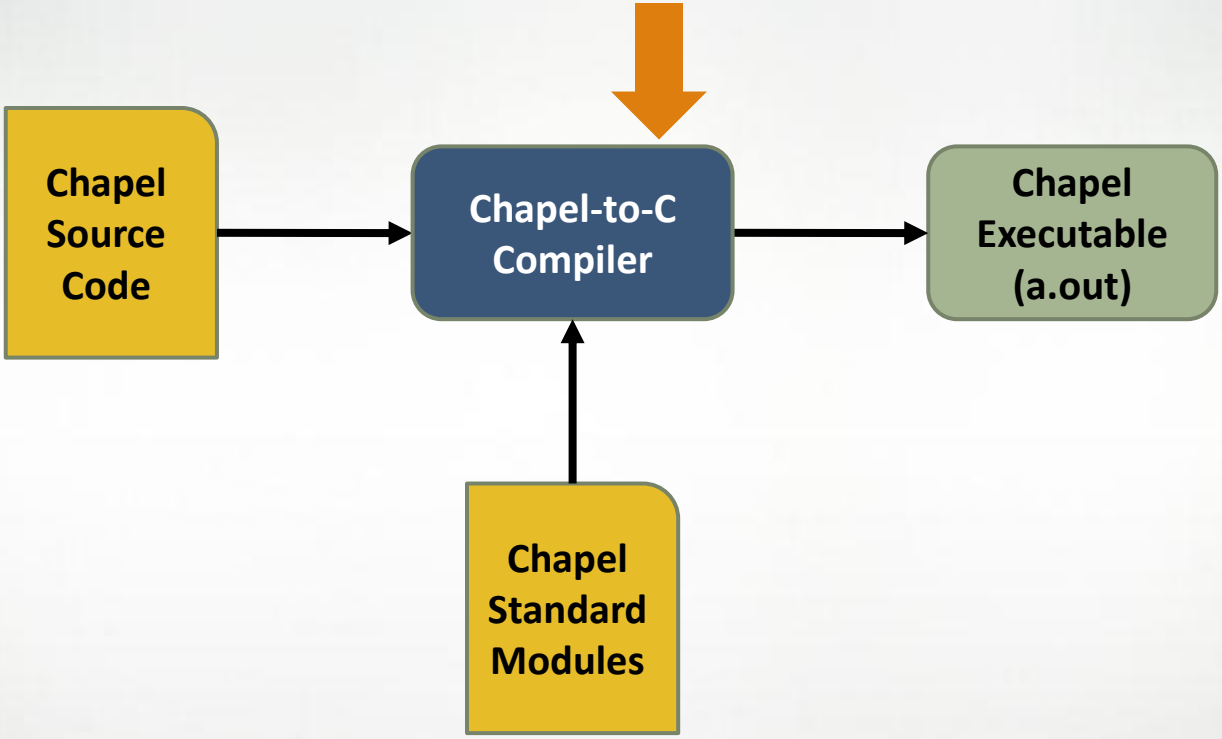
- **BlockDist**: Definition of Block distribution
- **BitOps**: Specialized bit manipulation
- **Random**: Random number generation
- **Time**: Timer and time-of-day support

  …

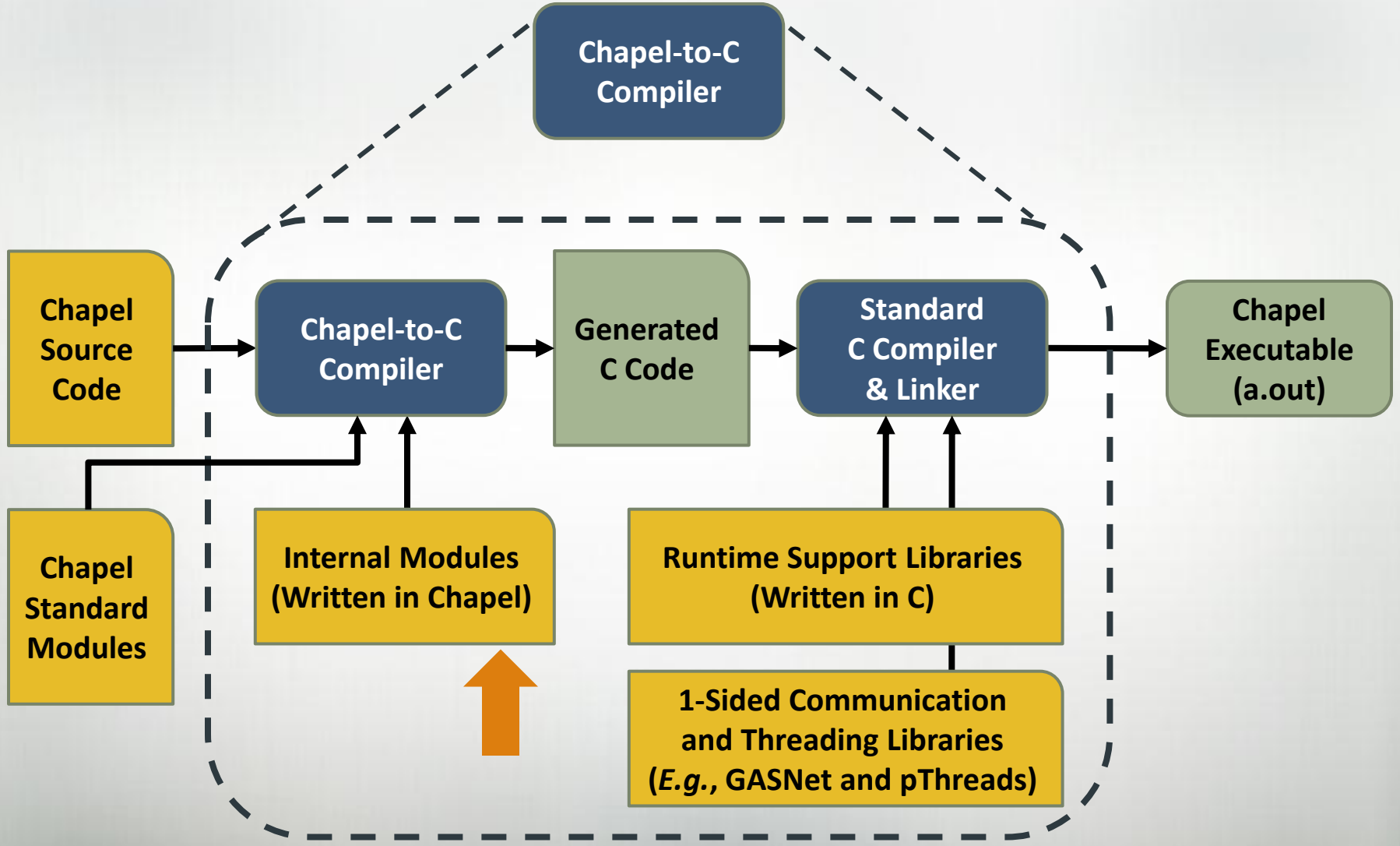
Standard modules must be explicitly used

E.g., `use BlockDist;`

Compiler Schematic



Detailed Compiler Schematic



Chapel Internal Modules

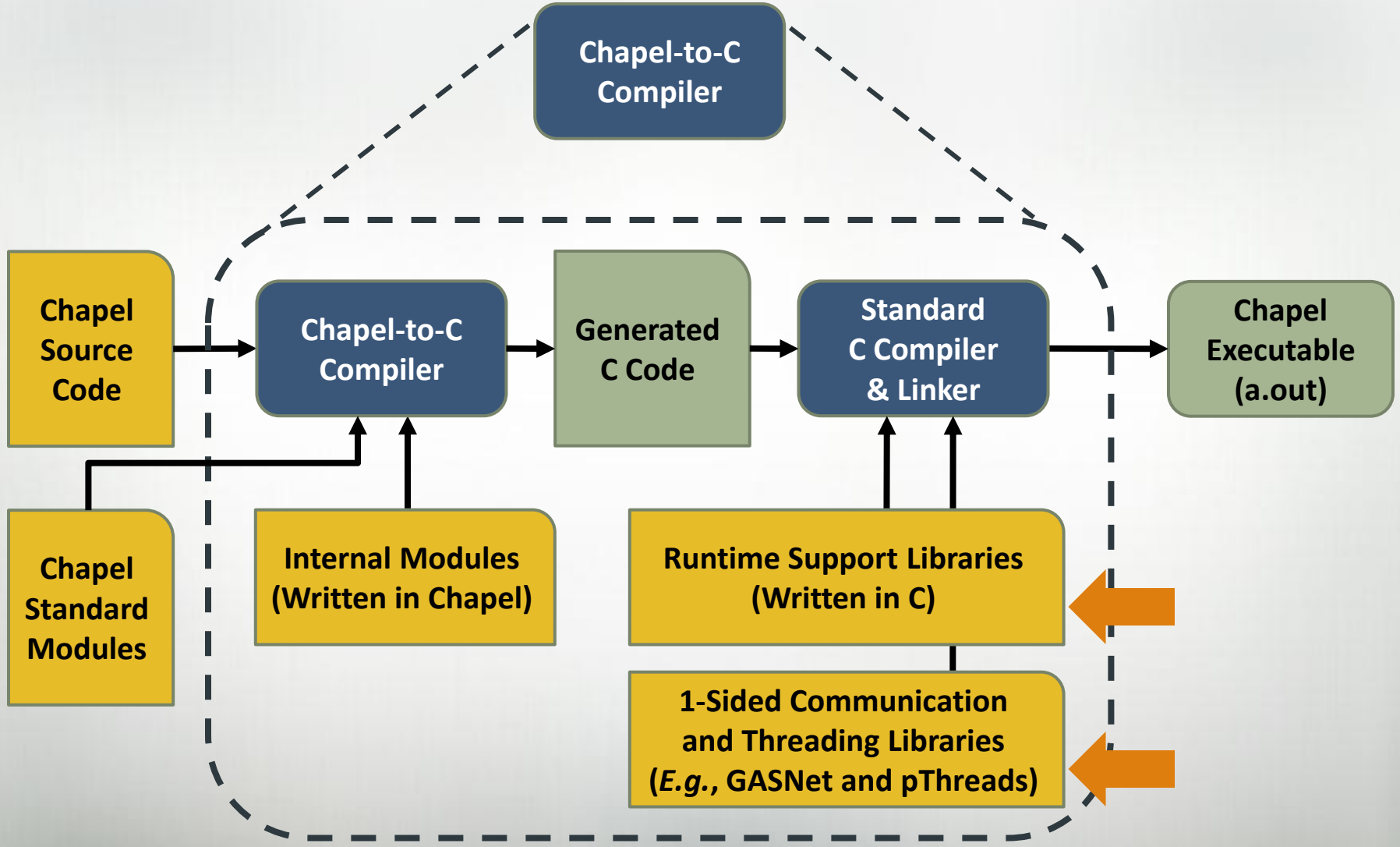
Internal modules implement basic Chapel features.

- Standard operators
- Standard math routines
- User-level I/O routines
- User-level assertions and halts
- Tuples, ranges, domains, and arrays
- Synchronization variables

Essential to development

- Improves robustness by using the language
- Makes development easier because Chapel is productive

Detailed Compiler Schematic



Runtime Support Libraries

Runtime support libraries bootstrap Chapel.

- Command-line argument passing
- Console and file I/O primitives
- Error handling
- Memory management
- Type conversions
- Time primitives
- Thread creation and management
- Inter-process communication and coordination

This functionality has been migrating to Chapel.

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Chapel Version 0.9

- Available on SourceForge
  http://sourceforge.net/projects/chapel/
- Distributed BSD Open Source license
- Systems: Linux/Unix, Mac, Cygwin
- Contents
  - Compiler and standard modules
  - Runtime and third-party libraries (e.g., GASNet)
  - Top-level README for quick start
  - Language spec, quick reference, HPCC tutorial
  - Examples (tutorials, programs, and HPCC benchmarks)
  - Portability scripts

Implementation Status

- Base language and task parallelism
  - Complete with minor gaps (*e.g.*, multiple inheritance)
- Data parallelism
  - Serial reference implementation
  - Initial support for concurrency via distributions
- Distributed memory
  - Task parallelism across locales
  - Initial support for distributed arrays and domains
- Performance
  - Focus on a small set of language features

Unimplemented Features Seen Today

- Base language
  - Constness is not checked for domains, arrays, fields
- Task parallelism
  - Atomic statements are not atomic
- Data parallelism
  - Promoted functions/operators do not preserve shape
  - Reductions and scans cannot be user-defined or partial
  - Arrays of arrays require inner arrays to use a single domain
- Locality and affinity
  - User-defined distributions are not yet specified