Chapel Overview

Elliot Ronaghan, Chapel Team, Cray Inc.

Chapel Lightning Talks, SC13, November 20th, 2013

What is Chapel?

- **An emerging parallel programming language**
  - Design and development led by Cray Inc.
    - with contributions from academics, labs, industry
  - Initiated under the DARPA HPCS program
- **Overall goal: Improve programmer productivity**
- **A work-in-progress**

Chapel's Implementation

- **Being developed as open source at SourceForge**
- **Licensed as BSD software**
- **Target Architectures:**
  - Cray architectures
  - multicore desktops and laptops
  - commodity clusters
  - systems from other vendors
  - (in-progress: CPU+accelerator hybrids, manycore, …)

Outline

- ✓ Chapel Context
- ➢ Chapel Background for today's talks
- ● Project Information

Task Parallelism and Synchronization

begin:

```
begin foo();     // create a task to run foo
bar();           // original task continues on
```

single:

```
var area1$, area2$: single real;
begin area1$ = computeArea(shape1);
begin area2$ = computeArea(shape2);

doSomethingElse();

const totalArea = area1$ + area2$
```

Data Parallelism

```
const D = {1..n} dmapped Cyclic(startIdx=1);
var A, B, C: [D] real;
forall (a,b,c) in zip (A,B,C) do
  a = b + alpha * c;
```

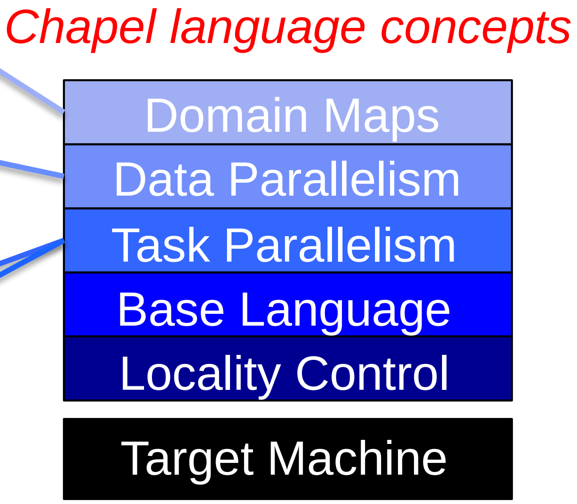
High-level features implemented…

- in Chapel
- using lower-level features
- by end-users

```
var area1$, area2$: single real;
begin area1$ = computeArea(shape1);
begin area2$ = computeArea(shape2);

doSomethingElse();

const totalArea = area1$ + area2$
```



Chapel language concepts

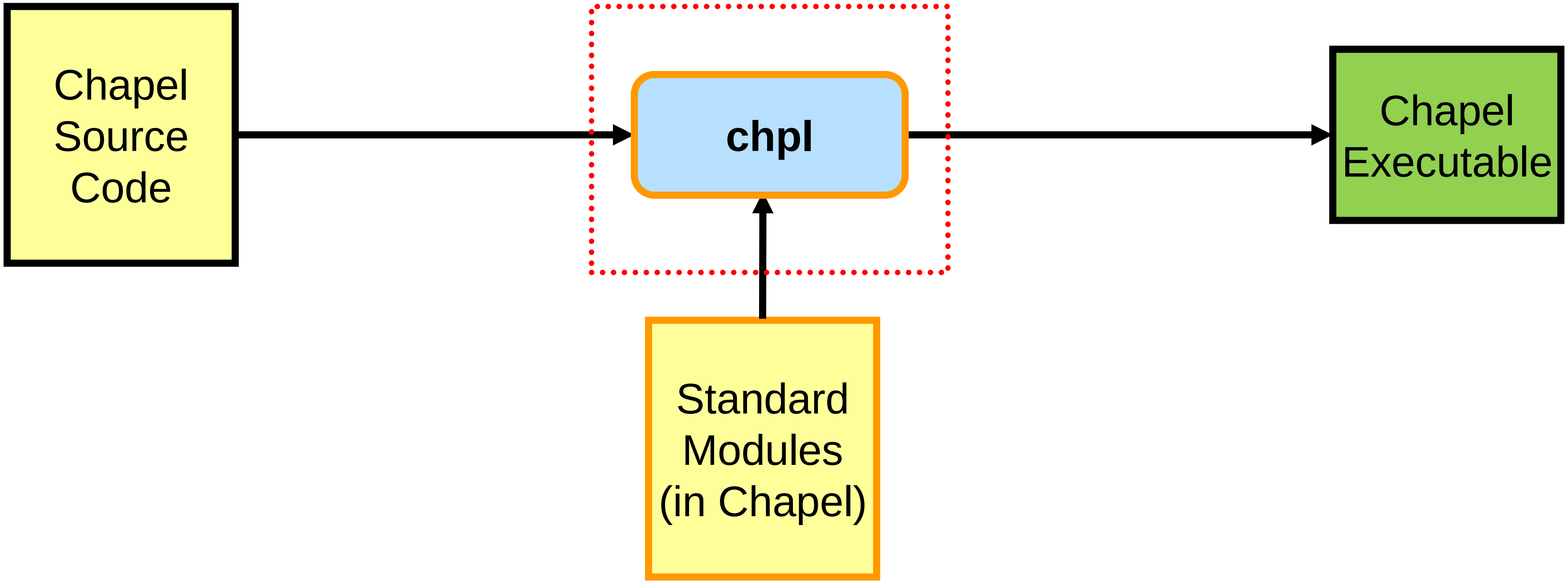
Chapel and Education

- **When teaching parallel programming, it's important to cover :**
  - data parallelism
  - task parallelism
  - concurrency
  - synchronization
  - locality/affinity
  - deadlock, livelock, and other pitfalls
  - performance tuning
  - …

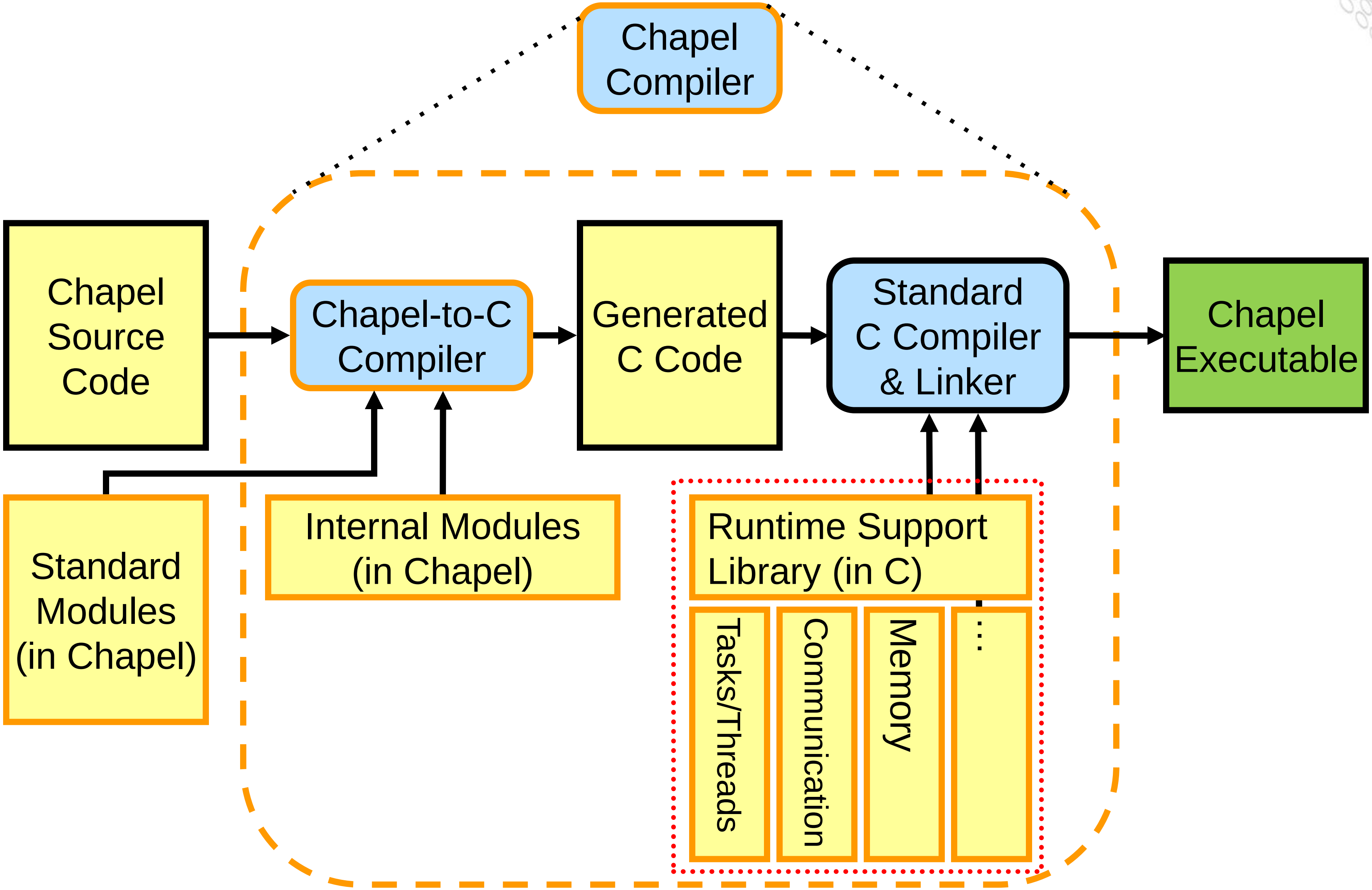
- **But there hasn't been a good language out there…**
  - for teaching *all* of these things
  - for teaching some of these things well at all
  - ***until now:*** We believe Chapel can potentially play a crucial role here

    (see http://chapel.cray.com/education.html for more information

Compiling Chapel



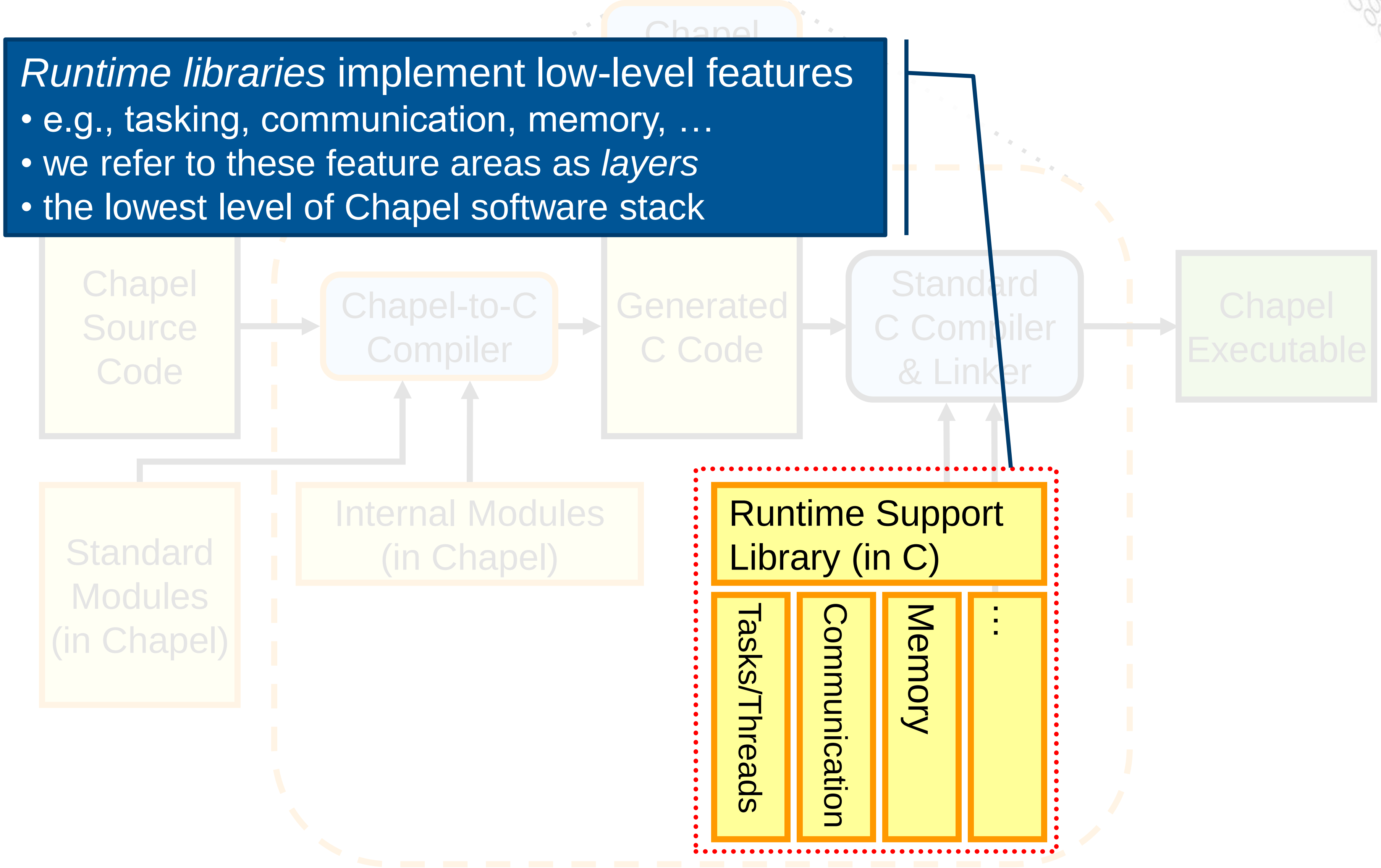
Chapel Compiler Architecture



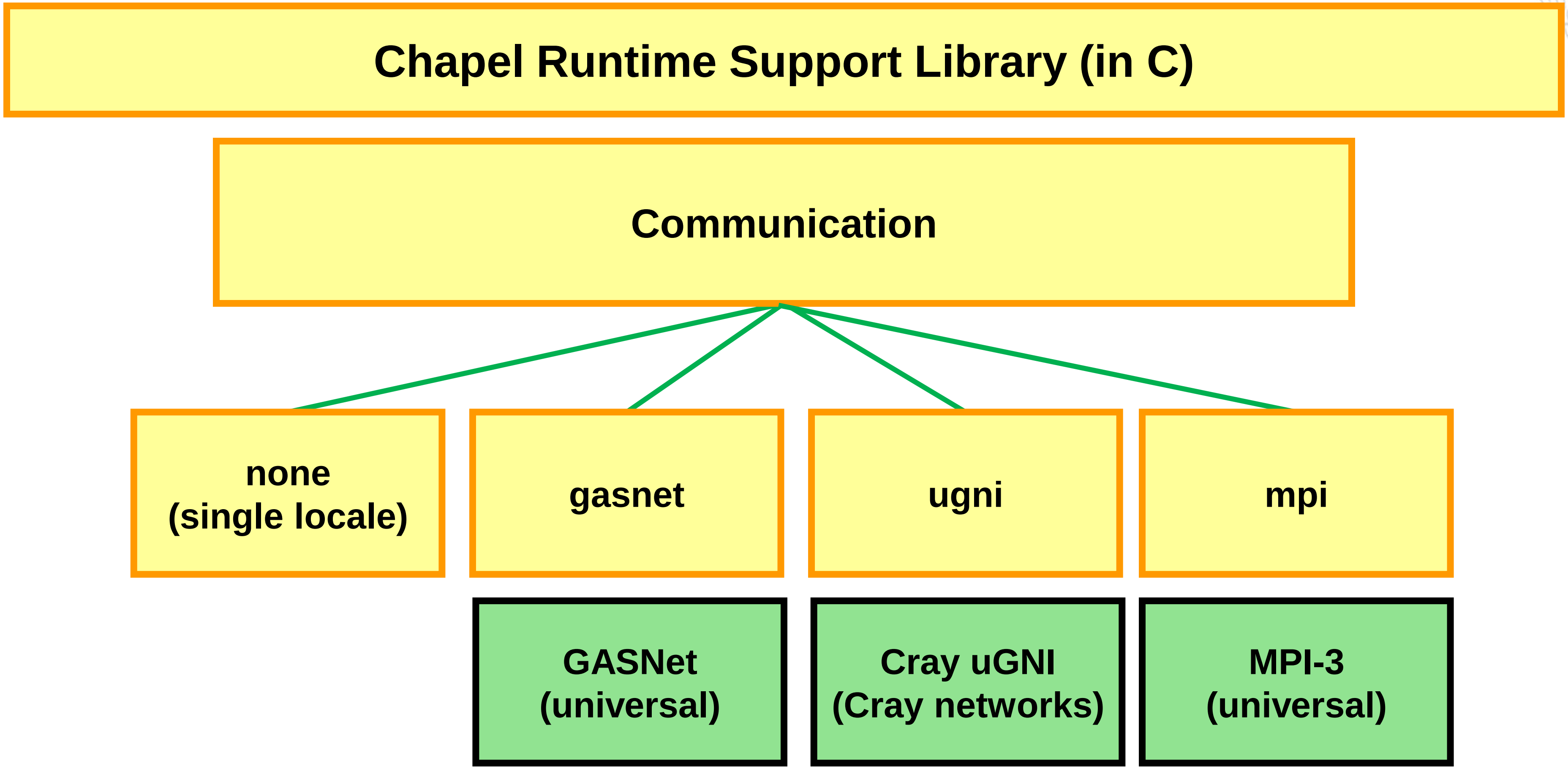
Chapel Compiler Architecture

Runtime libraries implement low-level features

- e.g., tasking, communication, memory, …
- we refer to these feature areas as *layers*
- the lowest level of Chapel software stack


Chapel
Chapel Source Code
Chapel-to-C Compiler
Generated C Code
Standard C Compiler & Linker
Chapel Executable
Standard Modules (in Chapel)
Internal Modules (in Chapel)
Runtime Support Library (in C)
Tasks/Threads
Communication
Memory
…

Runtime Communication Layer



Chapel Runtime Support Library (in C)

Communication

none
(single locale)

gasnet

ugni

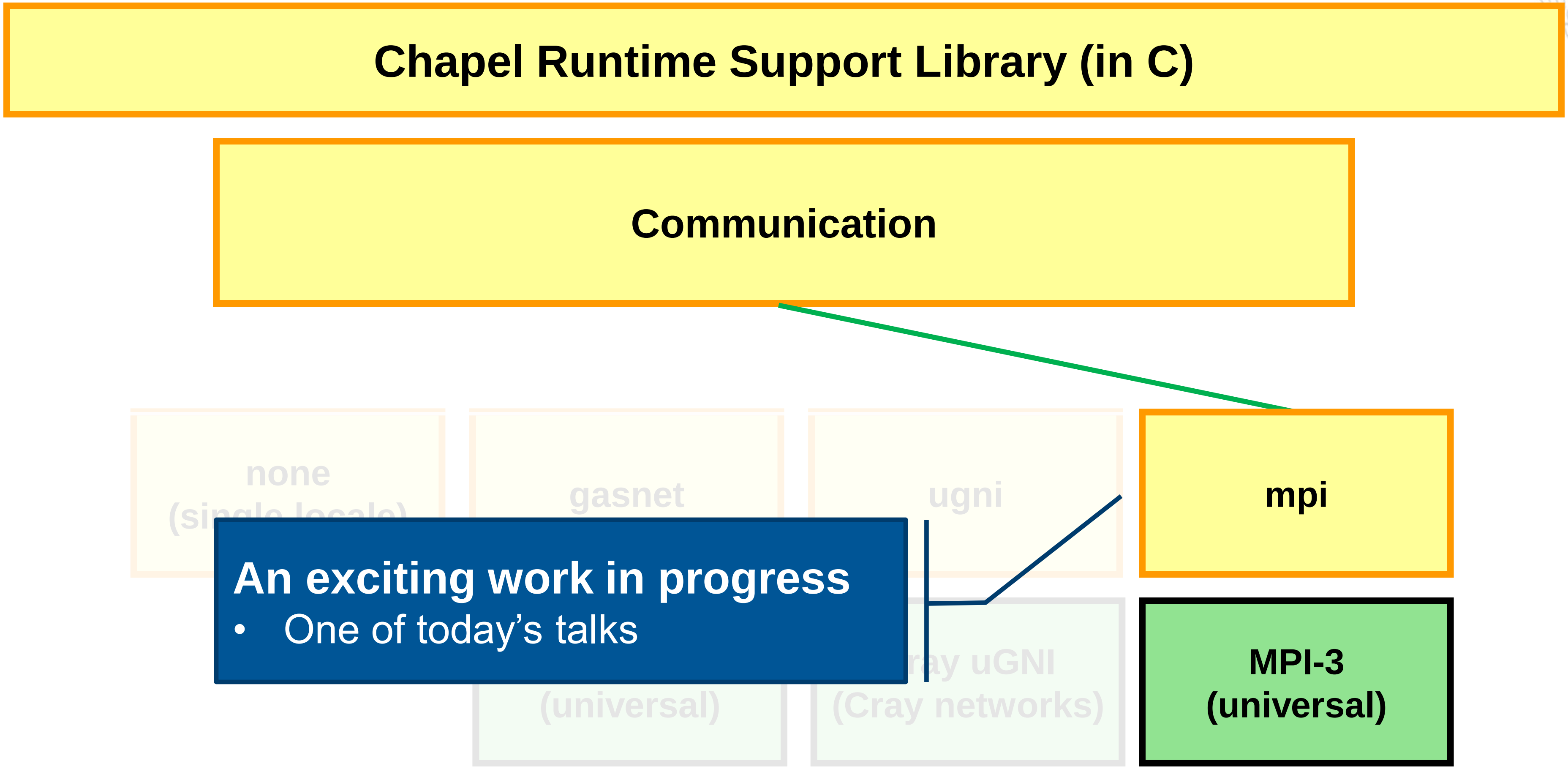
mpi

GASNet
(universal)

Cray uGNI
(Cray networks)

MPI-3
(universal)

Runtime Communication Layer



Chapel Runtime Support Library (in C)

Communication

none
(single locale)

gasnet

ugni

mpi

(universal)

Cray uGNI
(Cray networks)

MPI-3
(universal)

An exciting work in progress

- One of today's talks

Outline

- ✓ **Chapel Context**
- ✓ **Chapel Background for today’s talks**
- ➢ **Project Information**

Chapel…

…is a collaborative effort — join us!

CRAY

LTS Laboratory for Telecommunications Sciences

RICE

Sandia National Laboratories

Lawrence Livermore National Laboratory

BERKELEY LAB
Lawrence Berkeley National Laboratory

Argonne NATIONAL LABORATORY

OAK RIDGE National Laboratory

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle *Since 1965*

東京大学 THE UNIVERSITY OF TOKYO

uma UNIVERSIDAD DE MÁLAGA

UNIVERSITY OF MARYLAND

"I Like Chapel, how can I help?"

- **Let people know that you like it and why**
  - your colleagues
  - your employer/institution
  - Cray leadership (e.g., mention it at the Cray booth this week)
- **Help us evolve it from prototype to production**
  - contribute back to the source base
  - collaborate with us
  - help fund the effort
  - help us transition from "How will Cray make Chapel succeed?" to "How can we as a community make Chapel succeed?"

Resources For After Today

Chapel project page: http://chapel.cray.com

- papers, presentations, tutorials, language spec, …

Chapel SourceForge page: https://sourceforge.net/projects/chapel/

- release downloads, code repository, public mailing lists, …

IEEE TCSC Blog Series:

- *Myths About Scalable Parallel Programming Languages*

Mailing Lists:

- chapel_info@cray.com:
- chapel-users@lists.sourceforge.net: user-oriented discussion list
- chapel-developers@lists.sourceforge.net: dev.-oriented discussion
- chapel-education@lists.sourceforge.net: educator-oriented discussion
- chapel-bugs@lists.sourceforge.net chapel_bugs@cray.com : public/private bug forum

Chapel at SC13

- **Emerging Technologies Booth** (all week)
  - Booth #3547: staffed by Chapel team members; poster and handouts
- ✓ **Poster** (Tues @ 5:15)**:** *Towards Co-Evolution of Auto-Tuning and Parallel Languages*
  - ✓ Posters Session: Ray Chen (University of Maryland)
- ✓ **Talk** (Tues @ 3:20): *Hierarchical Locales: Exposing the Node Architecture in Chapel*
  - ✓ KISTI booth (#3713): Sung-Eun Choi (Cray Inc.)
- ➢ **Chapel Lightning Talks BoF** (Wed @ 12:15)
  - ➢ 5-minute talks on education, MPI-3, Big Data, Autotuning, Futures, MiniMD
- **Talk** (Wed @ 4:30)**:** *Chapel, an Emerging Parallel Language*
  - HPC Impact Theatre (booth #3947): Brad Chamberlain (Cray Inc.)
- **Happy Hour** (Wed @ 5pm): *4th annual Chapel Users Group (CHUG) Happy Hour*
  - Pi Bar (just across the street at 1400 Welton St): open to public, dutch treat
- **HPC Education** (Thus @ 1:30pm): *High-Level Parallel Programming Using Chapel*
  - David Bunde (Knox College) and Kyle Burke (Colby College)