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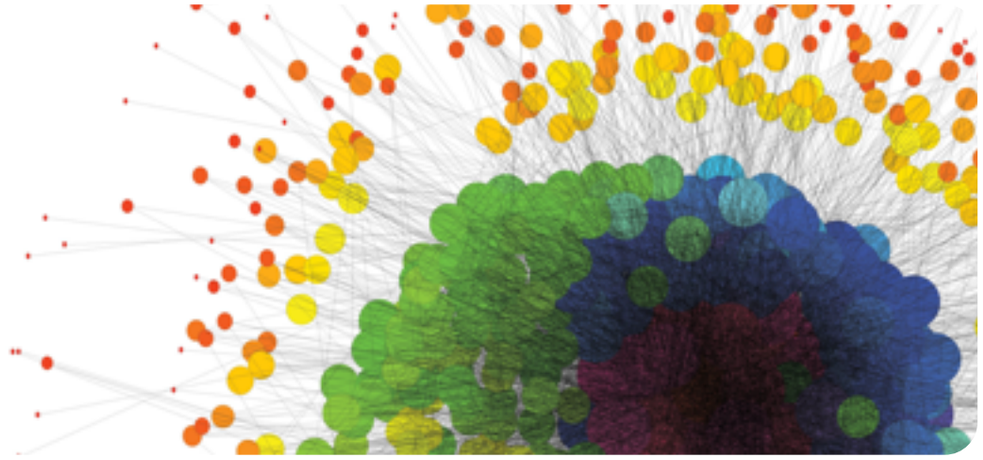

CRAY CHAPEL

Qthreads

Eureka! Task Teams!

Kyle Wheeler

SC'12 Chapel Lightning Talk

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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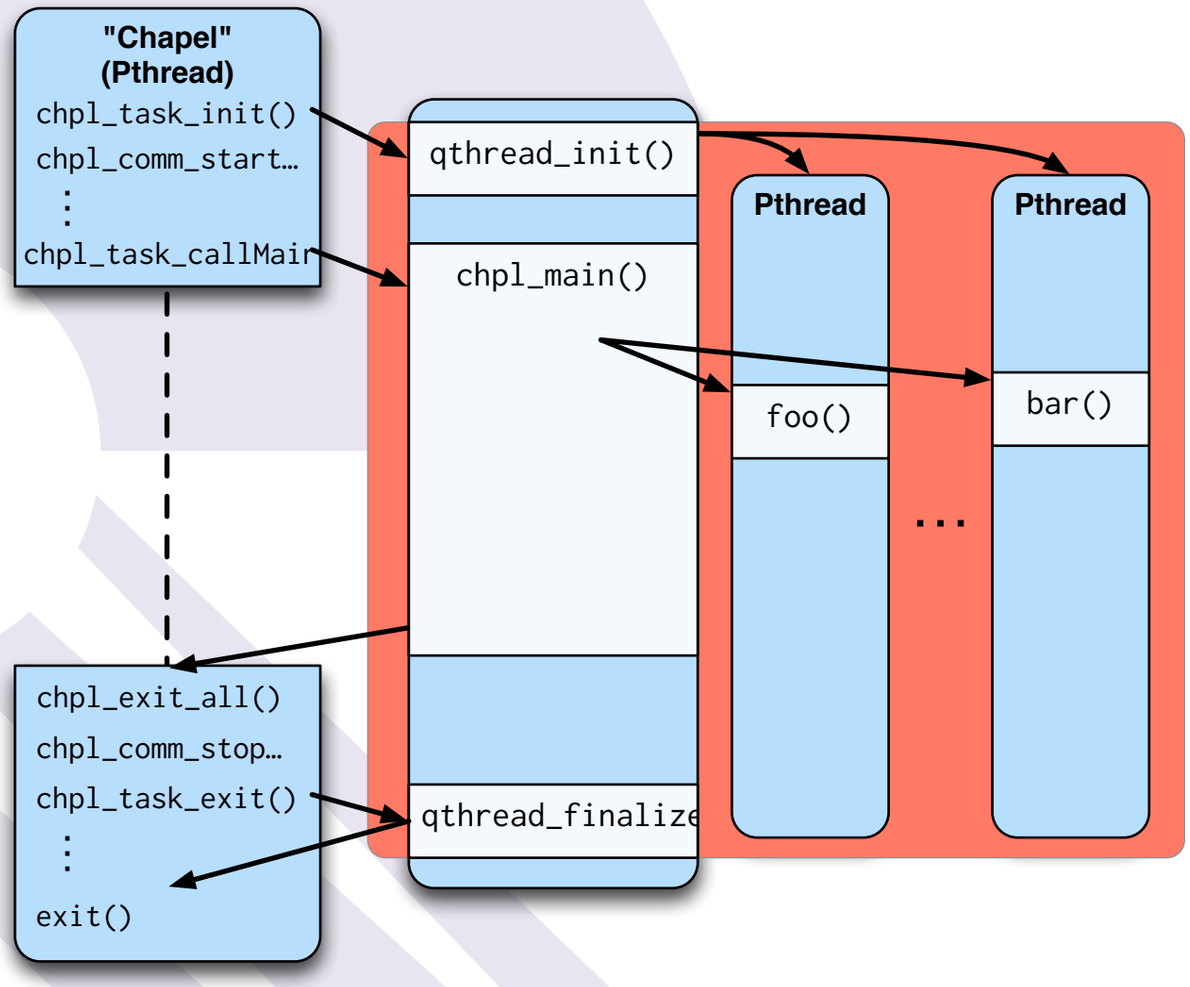
Chapel over Qthreads Summary

- What's Qthreads?
  - Locality-aware lightweight tasking library
  - Highly portable
    - IA32/64, AMD64, PPC32/64, SparcV9+, SST, Tilera, ARM
    - Linux, BSD, Solaris, MacOS X, Cygwin
  - Fine-grained synchronization: FEBs built-in
  - Advanced Locality-aware Scheduler (Sherwood)
- Chapel on Qthreads?
  - Thin translation layer
  - Qthreads environment "bolted on" the side
  - Separate from GASNet, so that they work together
  - **`CHPL_TASKS=qthreads`** when building



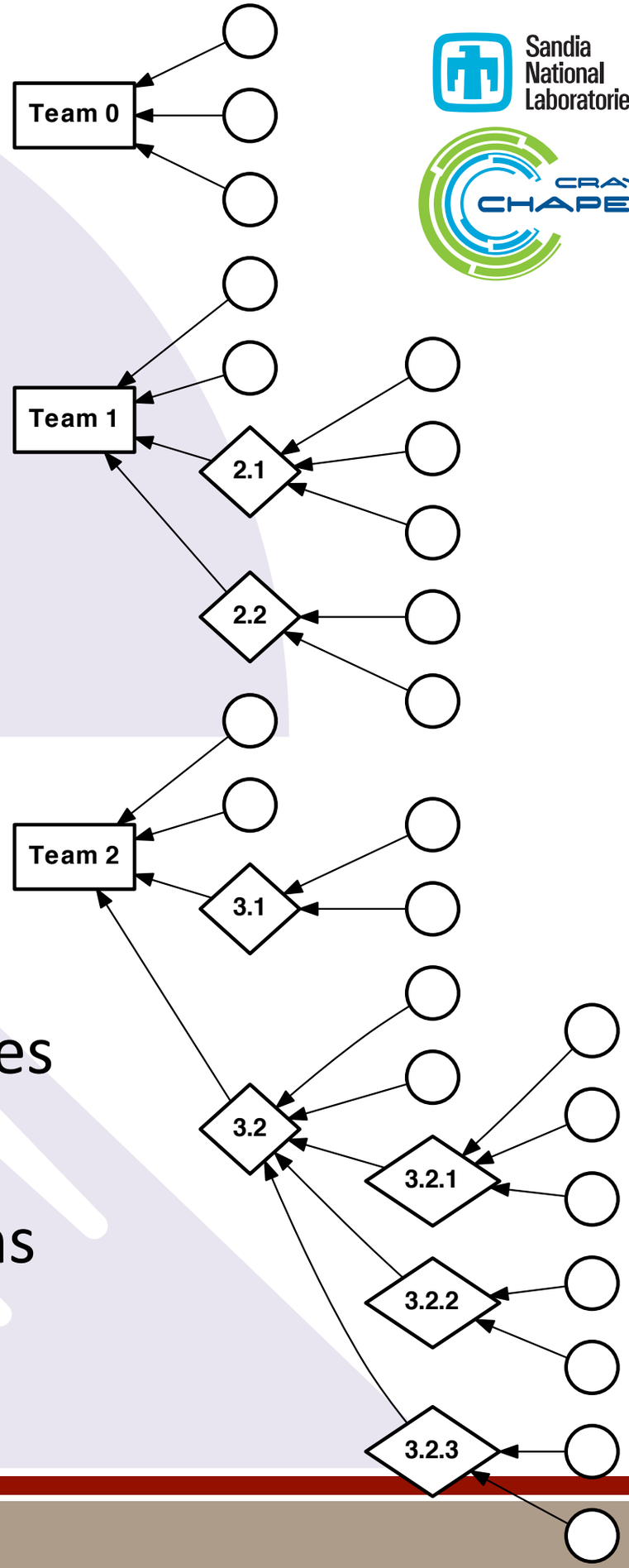
Progress in 2012…

- ✓ Better I/O handling
- ✓ System call interception & external synchronization handling
- ✓ Better operation under oversubscription
- ~ Better mapping from Chapel sync to Qthreads' FEBs

- This talk:
  - Task Teams
  - Eurekas and other collectives
  - Integrated inter-locale communication layer

Task Teams Concept

- All tasks belong to a team
  - Team “0” always runs “main”
- A task only belongs to one team
- New tasks can be spawned into:
  - Same team as parent
  - A new team
  - A new team dependent upon the parent team’s existence (subteam)
- An execution comprises a forest of team trees
  - Dynamically growing and contracting
- Tree structure encodes dependence relations
  - Recursive cascading kill of subteam tasks



Constructs that **could** use teams

- **Existing:**
  - Termination Detection
    - `forall`
    - `coforall`
    - `cobegin`
    - `sync`
- **New:**
  - Team-oriented Reductions
    - `submit();`
  - Team-oriented Broadcasts
    - `set();`
  - Team-oriented Barriers
    - `cobegin {`
      `func(1);`
      `func(2);`
      `func(3);`
      `}`
  - Eurekas
    - Parallel break
    - Recursive escape
    - Algorithm Race
  - Restartable Scopes
    - Resilience
    - `err_restart();`

Eureka Concept Example

```
proc search_inner(var target:int,
                  var n:node):node {
  if (n.value == target) {
    eureka;
    return n;
  } else {
    begin search_inner(target, n.leftchild);
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  }
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proc search(var target:int, var n:node):node {
  var f:node;
  newteam_begin f = search_inner(target, n);
}

var found : node = search(5, bigtree.root);
writeln("text of node 5 is: " + found.text);
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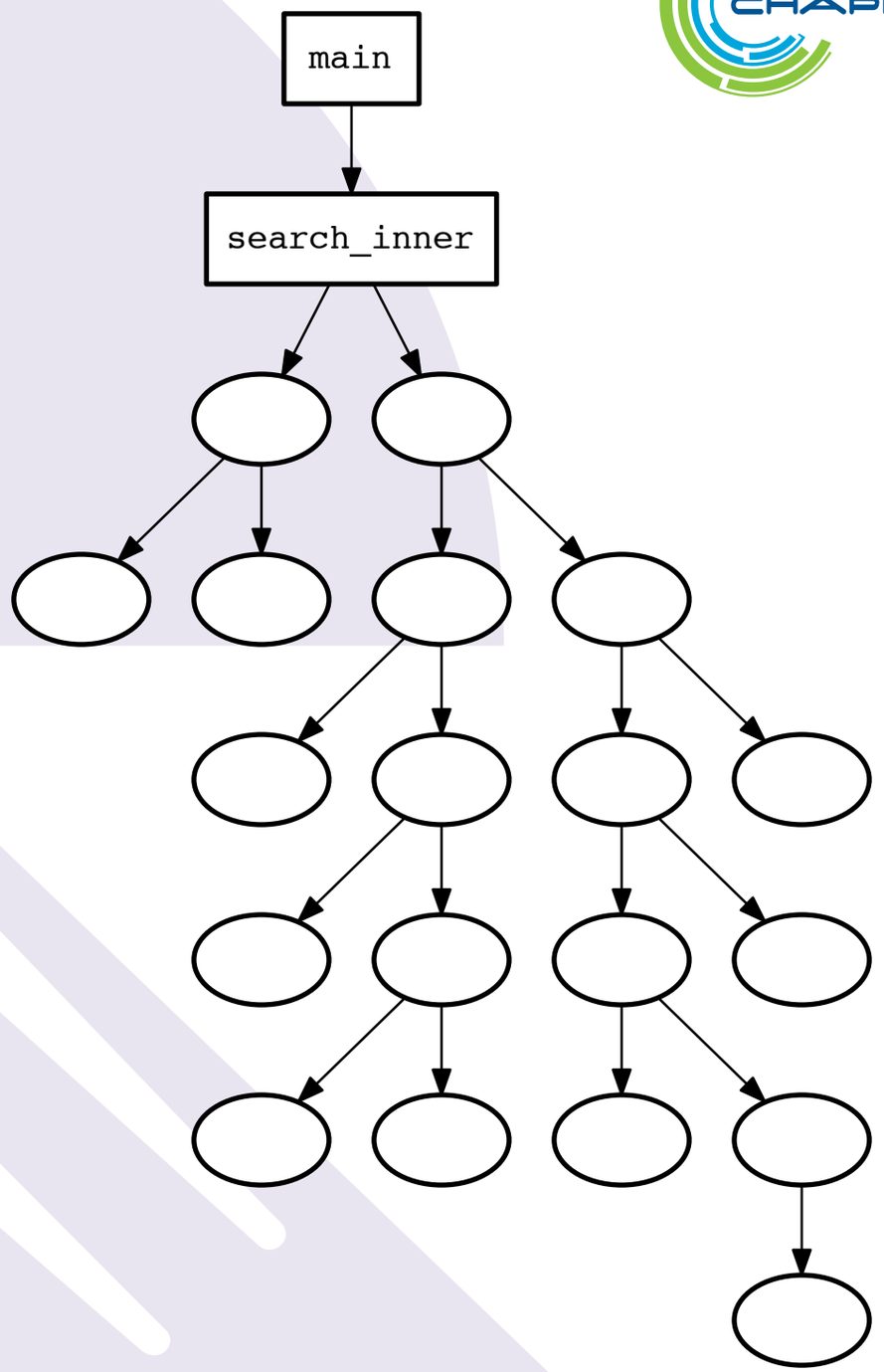

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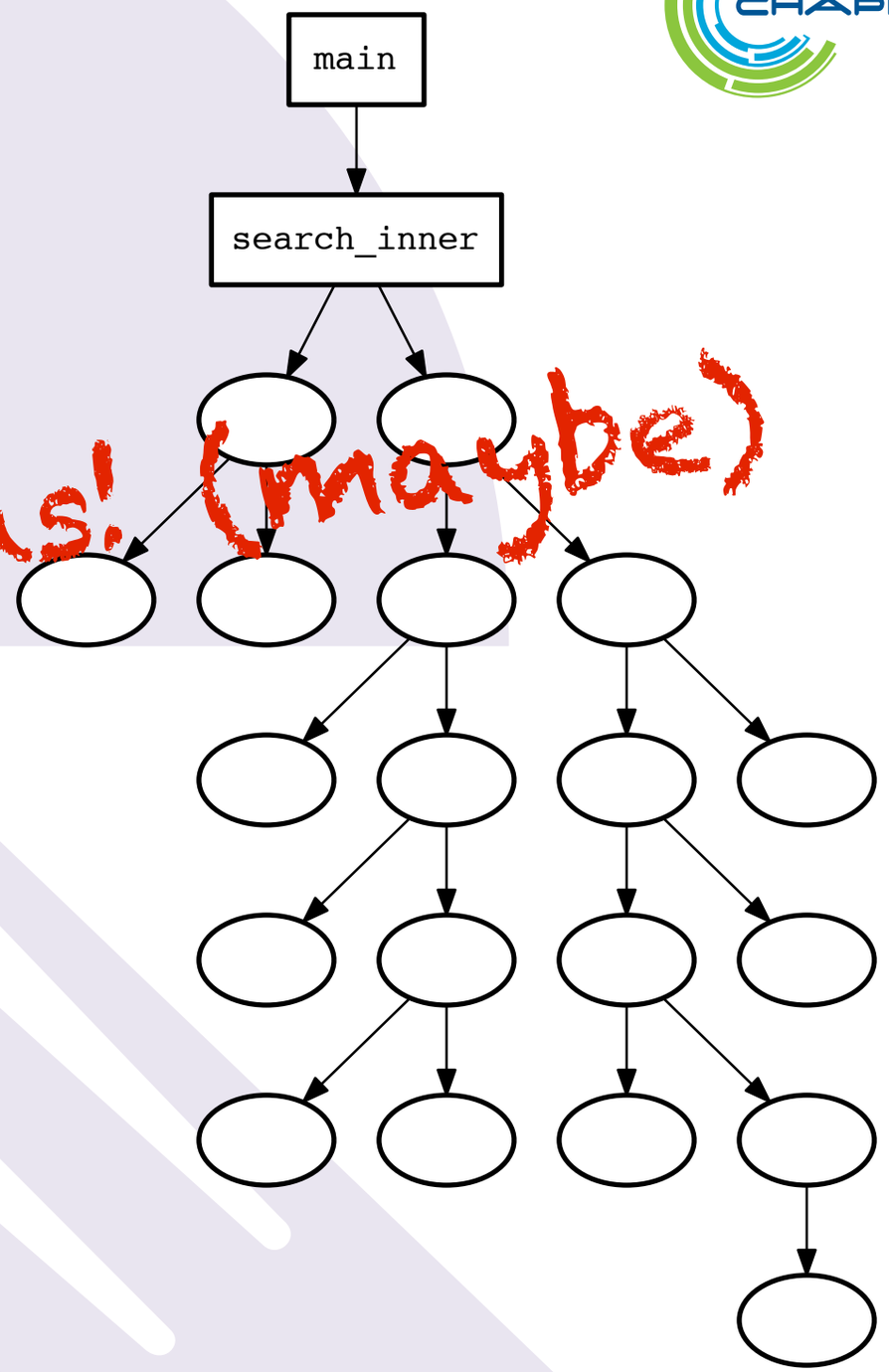
New Keywords! (maybe)



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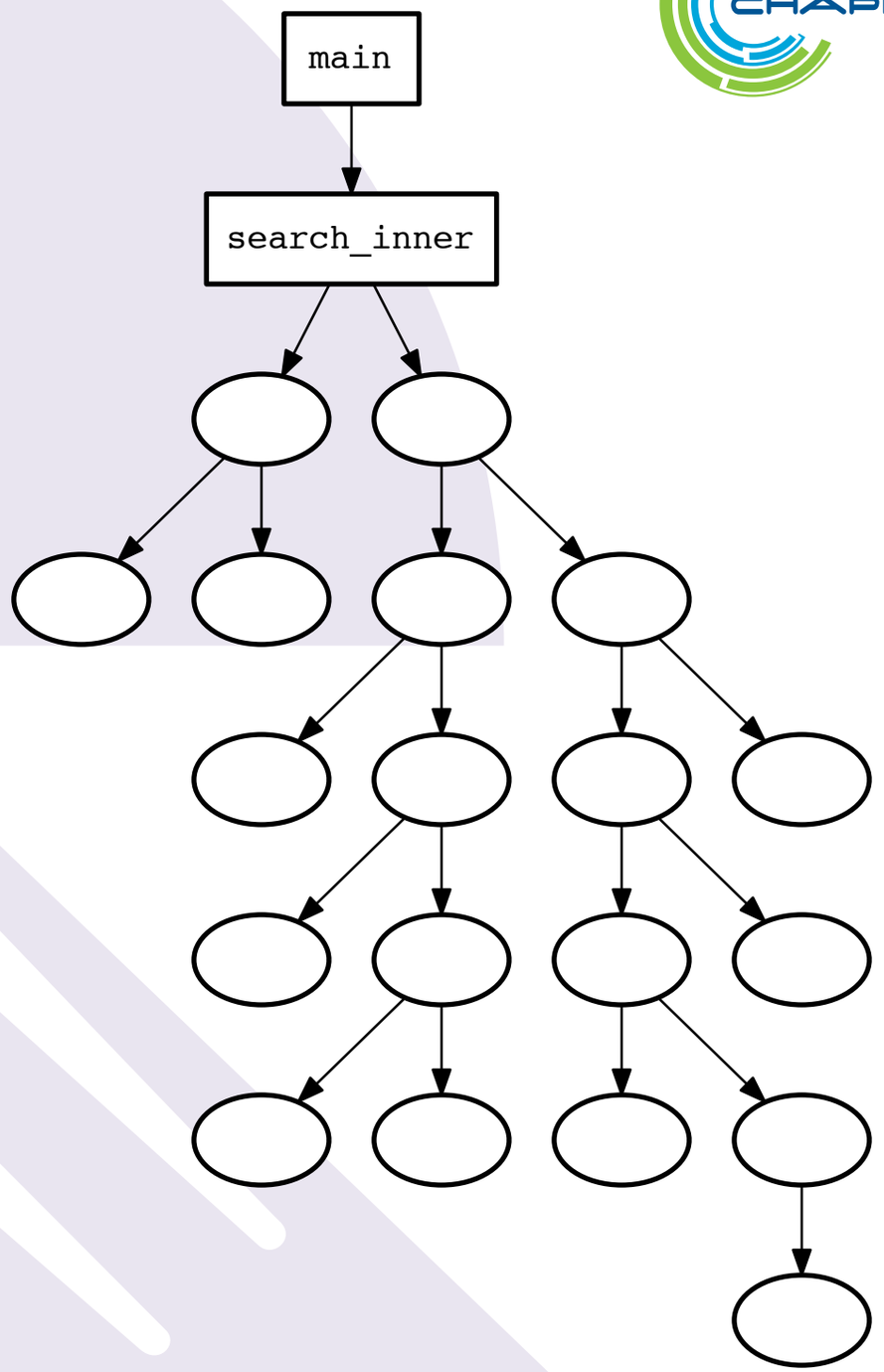

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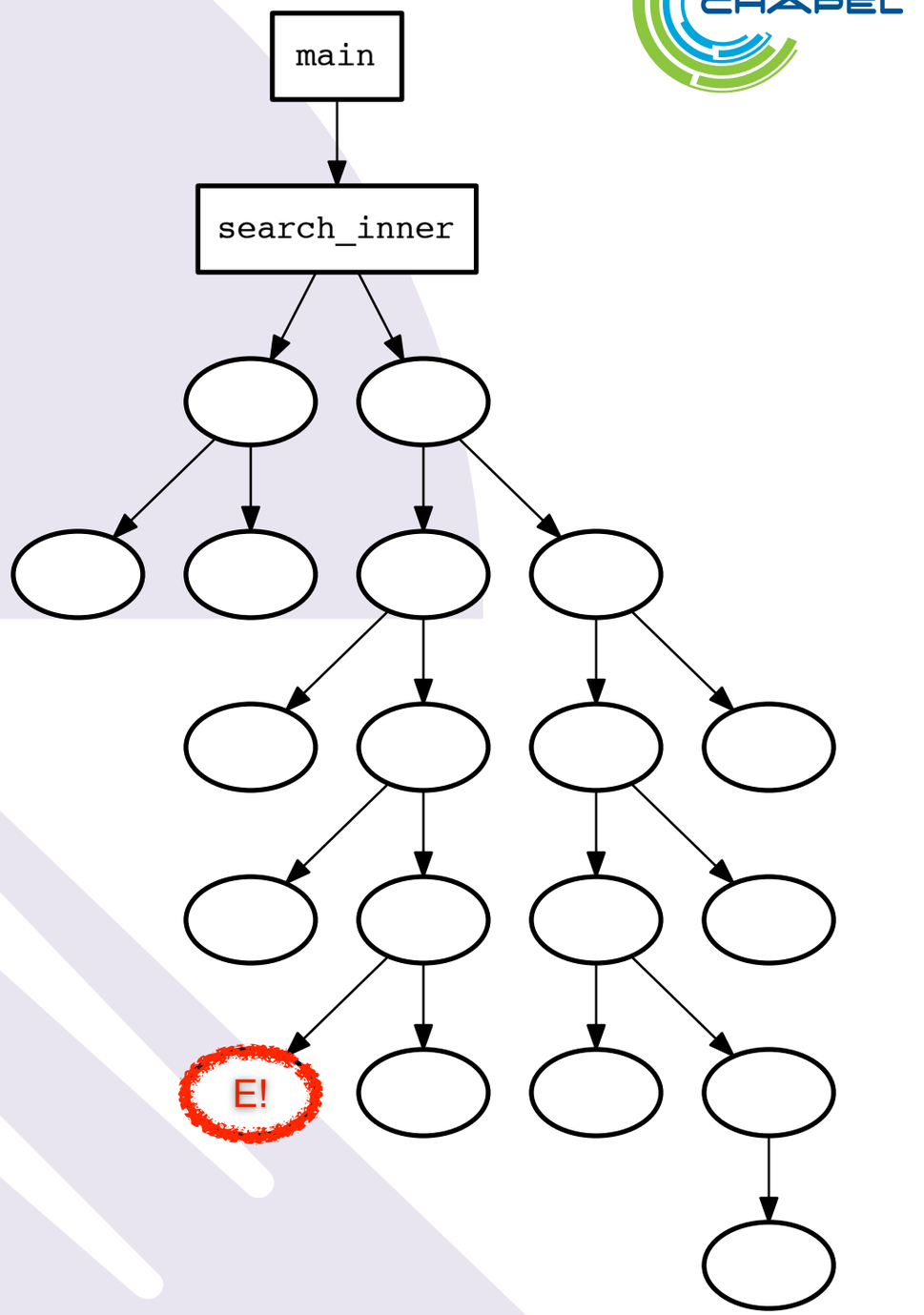

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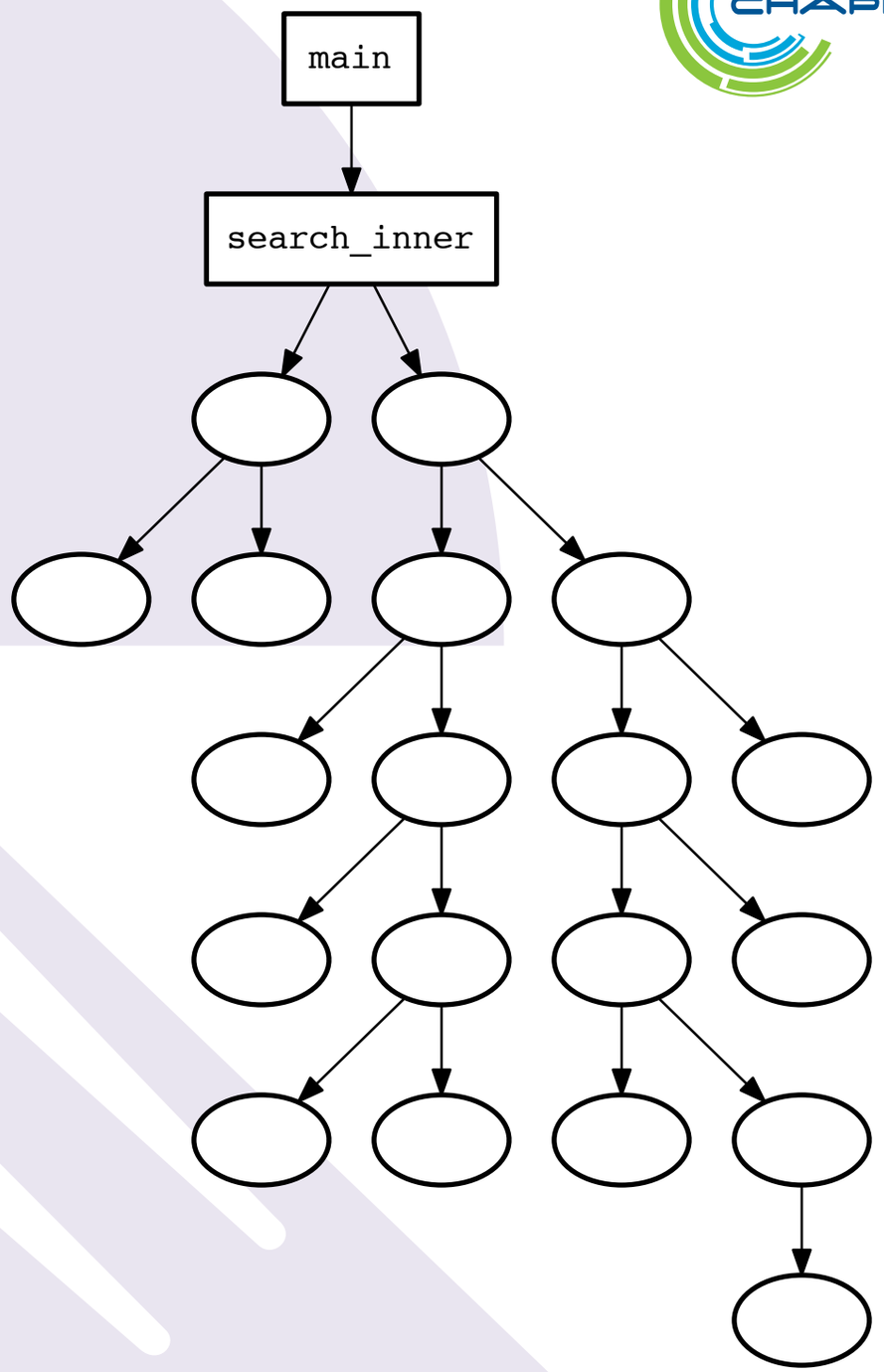

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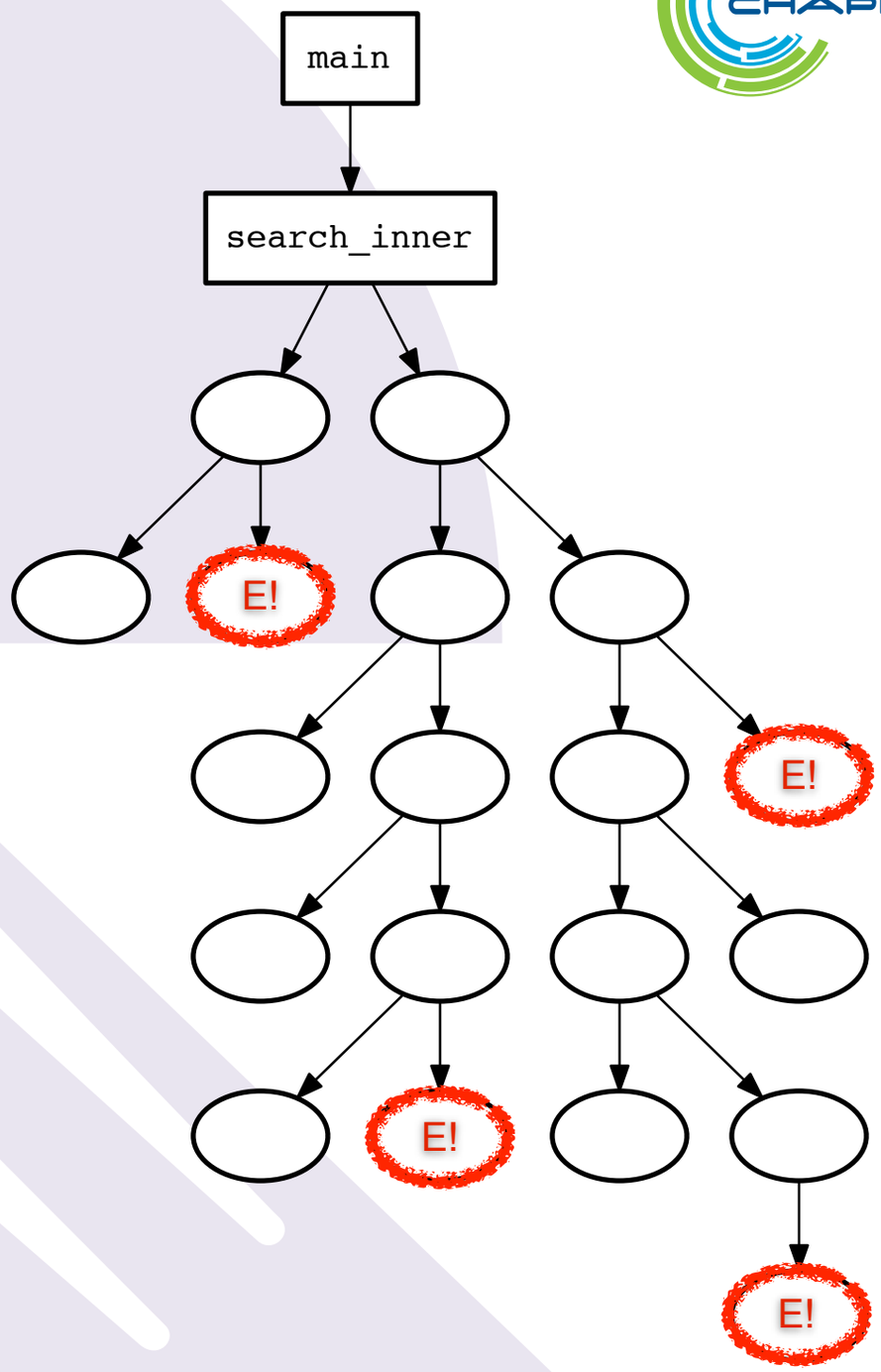

Current Work: SPR

- Integrated tasking runtime and communication
  - Remote task spawn
  - Local task synchronization
  - Data movement
- Opportunities for optimized interplay
  - Synchronization across the network
  - Work-stealing and load-balancing
  - Progress support
- Transparent to the user
  - `CHPL_TASKS=spr`
  - `CHPL_COMM=spr`