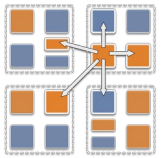
Dynamic Load Balancing

- Object-based decomposition (i.e. virtualized decomposition) helps
  - Allows RTS to remap them to balance load
  - But how does the RTS decide where to map objects?
  - Just move objects away from overloaded processors to underloaded processors
  - How is load determined?



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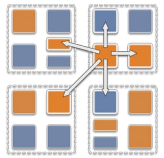
Measurement Based Load Balancing

- Principle of Persistence
  - Object communication patterns and computational loads tend to persist over time
  - In spite of dynamic behavior
    - Abrupt but infrequent changes
    - Slow and small changes
  - Recent past is a good predictor of near future
- Runtime instrumentation
  - Measures communication volume and computation time
- Measurement-based load balancers
  - Measure load information for chares
  - Periodically use the instrumented database to make new decisions and migrate objects
  - Many alternative strategies can use the database



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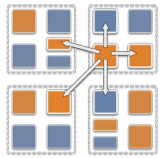
Using the Load Balancer

- Link a LB module
  - `-module <strategy>`
  - RefineLB, NeighborLB, GreedyCommLB, others
  - EveryLB will include all load balancing strategies
- Compile time option (specify default balancer)
  - `-balancer RefineLB`
- Runtime option (override default)
  - `+balancer RefineLB`



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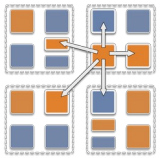
Instrumentation

- By default, instrumentation is enabled
  - Automatically collects load information
- Sometimes, you want LB decisions to be based only on a portion of your program
  - To disable by default, provide runtime argument `+LBOff`
  - To toggle instrumentation in code, use `LBTurnInstrumentOn()` and `LBTurnInstrumentOff()`



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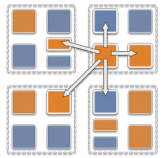
Code to Use Load Balancing

- Write PUP method to serialize the state of a chare
- Set `usesAtSync = true;` in chare constructor
- Insert `AtSync()` call at a natural barrier
  - Call from every chare in all collections
  - Does not block
- Implement `ResumeFromSync()` to resume execution
  - A typical `ResumeFromSync()` contributes to a reduction



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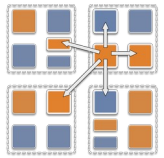
Example: Stencil

```
// Synchronize at every iteration: Main starts next iteration
void Main::endIter() { stencilProxy.sendBoundaries(); }

// Assume a 1D Stencil chare array with near neighbor
communication
void Stencil::sendBoundaries() {
  thisProxy(wrap(x-1)).updateGhost(RIGHT, left_ghost);
  thisProxy(wrap(x+1)).updateGhost(LEFT, right_ghost);
}

void Stencil::updateGhost(int dir, double ghost) {
  updateBoundary(dir, ghost);
  if (++remoteCount == 2) {
      remoteCount = 0;
      doWork(); } }
```



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Example: Stencil cont.

```
void Stencil::doWork() {
  underThreshold = (computeKernel() < DELTA);

i          ons
  else { contribute(CkCallback(CkReductionTarget(Main, endIter),
mainProxy)); }
}
```