Array, Domain, & Domain Map Improvements

Chapel Team, Cray Inc.
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Outline

- Forwarding on Domain Maps
- Bulk Transfer Interface Redesign
- Subtype Queries on Distributions
- Other Array, Domain, Domain Map Improvements
Forwarding on Domain Maps
Forwarding on Domain Maps: Background

- Some domain maps benefit from custom methods
  - E.g., StencilDist.updateFluff() performs ghost cell exchanges

- Exposing custom methods required working with internals
  - Declaring a wrapper method on internal "_array" type
    ```
    proc StencilArr.updateFluff() { ... }
    ```
    ```
    proc _array.updateFluff() where isStencil(this._value) {
        this._value.updateFluff();
    }
    ```
  - Or calling method on undocumented "_value" field
    ```
    myArray._value.methodWithoutWrapper();
    ```
Forwarding on Domain Maps: Effort and Impact

This Effort:
- Implemented forwarding of methods on domain maps
  - Can now do away with wrapper methods
    \[
    \texttt{proc StencilArr.updateFluff() \{ \ldots \}}
    \]
  - No longer need to access "\_value" for wrapper-less methods
    \[
    \texttt{myArray.methodWithoutWrapper();}
    \]

Impact:
- Easier to write custom methods on domain maps
- Simplified and improved existing code
  - Removed existing \_array wrappers around custom methods
  - Removed more uses of "\_value" from tests
- Fulfilled “custom interface” concept from original domain map paper
Bulk Transfer Interface Redesign
Bulk Transfer Redesign: Background

- **Bulk transfer interface allows for optimized assignment**
  - Lets domain map authors perform assignments themselves
  - Allows for less overhead based on knowledge of memory layout

- **Original interface was overly complex**
  - Required an excessive number of methods to implement
  - Too much information baked into method names
    - "doiCanBulkTransfer"
    - "doiCanBulkTransferStride"
    - "doiBulkTransferToDR"
Bulk Transfer Redesign: Background (cont.)

- **Problem:** How to pick between domain maps' methods?
  - 'Dest.from(Source)', or 'Source.to(Dest)'?
  - Problem for transfers between standard and package domain maps
    
    // Block.to(Package) - Suboptimal transfer using local arrays
    // Package.from(Block) - Optimal transfer using GETs/PUTs
    
    packageArr = standardBlockArr;

- **Standard dists can't know about custom dists**
  - Custom dists do know about standard dists
Bulk Transfer Redesign: This Effort

- Designed and implemented a new interface
  - Two kinds of information encoded in method name:
    - Direction (To/From) and preferred method (Known/Any)
  - Support determined by attempting to resolve methods

\[
\text{proc } \text{doiBulkTransfer}[\text{To|From}][\text{Known|Any}](\text{myDom:domain, otherDMap, otherDom:domain}) : \text{bool};
\]

- Simpler interface that supports preferred methods
  - 'Known' methods are attempted before 'Any' methods

<table>
<thead>
<tr>
<th>Package = Block</th>
<th>Resolved?</th>
<th>Called?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block.toKnown(Pkg)</td>
<td>False</td>
<td>False</td>
</tr>
<tr>
<td>Pkg.fromKnown(Block)</td>
<td>True</td>
<td>True</td>
</tr>
<tr>
<td>\text{Block.toAny(Pkg)}</td>
<td>True</td>
<td>False</td>
</tr>
</tbody>
</table>
Bulk Transfer Redesign: Impact and Next Steps

**Impact:** Less work for domain map authors
- Interface support determined by reflection in internal modules
- Return 'false' if the transfer cannot be completed
  - Caller is then responsible for completing the transfer

**Next Steps:**
- Re-examine bulk transfer of standard distributions
  - Contributed pre-2014, many things have since changed
- Provide helper functions for more advanced usage
  - Wrap reflection-testing of interface support
Subtype Queries on Distributions
Subtype Queries on Distributions

**Background:** Querying domain's distribution type was messy
- Users can access domain's distribution through "domain.dist"
- Querying type involved using undocumented internals
  ```prolog
  proc foo(D : domain) where D.dist._value: Block { ... } 
  ```

**This Effort:** We now support subtype queries on "domain.dist"
  ```prolog
  proc foo(D : domain) where D.dist: Block { ... } 
  ```

**Impact:** Can eliminate more uses of "_value" in tests/modules

**Next Steps:**
- Continue removing uses of "_value" from tests
- Retire special interpretation of ‘:’ in where-clauses
Other Array, Domain, Domain Map Improvements
Other Array, Domain, Domain Map Changes

- Sparse CS domains can now have a sparse parent domain
- Support for querying the stridability of sparse domains
- Support for strided Block-sparse domains and arrays
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