Simplified UPC Collectives

Two new forms of the standard UPC collective functions offer higher productivity through more expressive interfaces

One-Sided Collectives

Definition: A ***one-sided collective*** is an operation initiated by one thread that accesses or changes memory in all threads' partitions.

Standard UPC contains one-sided collective library operations, such as **`upc_global_alloc()`**. One-sided alternatives to the standard data movement and computational collectives are now being evaluated on several platforms..

Data Movement Collectives:

```
void mupc_broadcast(shared void *src,
                    size_t n)
```

The **`n`** bytes at **`src`** are copied to corresponding areas of shared memory on all threads. The broadcast is "in place". **`src`** need not have affinity to the caller. The broadcast is complete at the beginning of the next synchronization phase.

Computational Collectives:

```
TYPE mupc_reduceT(shared void *src,
                  size_t n, upc_op_t op)
```

A reduction with operation **`op`** is performed over the **`n`** corresponding elements of **`src`** of type **`TYPE`** on all threads. The result is available to the calling thread upon return.

Usage comparison:

Find the min and max of shared array **`A`**:

Standard UPC collective library:

```
#define N  10000
shared [N] double A[N*THREADS];
shared []  double MinMax0[2];          // targets of reduction
shared [2] double MinMax[2*THREADS];   // targets of broadcast

upc_all_reduceD( &MinMax0[0], A, UPC_MIN, N*THREADS, N, NULL, UPC_IN_ALLSYNC | UPC_OUT_MYSYNC );
upc_all_reduceD( &MinMax0[1], A, UPC_MAX, N*THREADS, N, NULL, UPC_IN_MYSYNC | UPC_OUT_MYSYNC );
upc_all_broadcast( MinMax, MinMax0, 2*sizeof(double), UPC_IN_MYSYNC | UPC_OUT_ALLSYNC);
```

One-sided collectives:

```
shared [2] double MinMax[2*THREADS];

upc_barrier;
if (MYTHREAD==0) {
    // one-sided reductions of min and max
    MinMax[0] = mupc_reduceD( A, N, UPC_MIN );
    MinMax[1] = mupc_reduceD( A, N, UPC_MAX );

    // one-sided broadcast of min and max
    mupc_broadcast( MinMax, 2*sizeof(double) );
    }
upc_barrier;
```

Value-Based Collectives

Definition: A ***value-based collective*** is a wrapper that provides a "one-liner" for scalar collective operations.

Value-based collectives are implemented as a generic header file that works with any UPC-1.2 compliant compiler.

Data Movement Collectives:

```
TYPE bupc_allv_broadcast(TYPE, TYPE value,
                         int rootthread)
TYPE *bupc_allv_gather_all(TYPE, TYPE value,
                           TYPE *destarray)
```

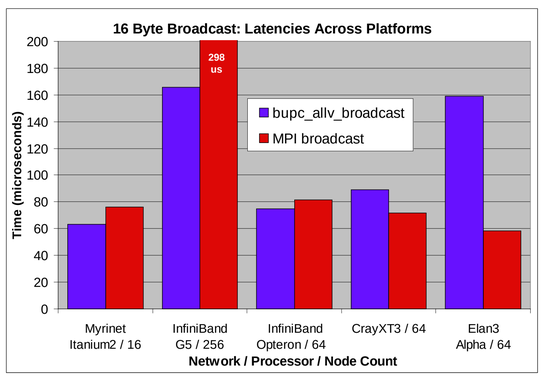
`TYPE` may be scalar or aggregate (**`struct`** or **`union`**) type. Array parameters are pointer-to-local for the calling thread. Also have variants for scatter, gather and permute.

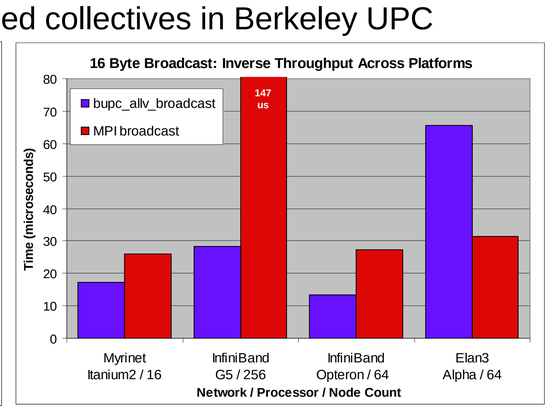
Computational Collectives:

```
TYPE bupc_allv_reduce_all(TYPE, TYPE value,
                          upc_op_t op)
```

`TYPE` must be scalar. A reduction with operation **`op`** is performed over the values provided by all threads. The result is returned to all threads. Also have variants for reduce and prefix_reduce.

Performance of the Value-based collectives in Berkeley UPC





Value-based collectives:

```
shared [] double *lA = (shared [] double *)&A[N*MYTHREAD];
double localmin = lA[0], localmax = lA[0];

// compute localmin & localmax over my data…
for (int i=1; i < N; i++) {
  localmin = MIN(localmin, lA[i]);
  localmax = MAX(localmax, lA[i]);
}

// perform the collective reduction
double min = bupc_allv_reduce_all(double, localmin, UPC_MIN);
double max = bupc_allv_reduce_all(double, localmax, UPC_MAX);
```

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