One-Sided Append: A New Communication Paradigm For PGAS Models

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NAS Integer Sort (IS) Key Exchange

```c
int dst_buf[DST_BUF_SIZE]; /* Symmetric buffer for RX of keys */
int counter = 0;            /* Symmetric integer offset counter */
...
for (i = 0; i < num_pes; i++) {
    int dst_off;

    dst_off = shmem_int_fadd(&counter, cnt[i], i);
    shmem_int_put(dst_buf+dsf_off, src_buf+src_off[i], cnt[i], i);
}
```

Key-exchange portion of integer bucket sort algorithm

Receiver’s buffer management is done by the sender
- Requires additional fetch-add message from the sender
- Alternative is to pre-arrange buffer space

Sidebar: Iterations can be overlapped with nonblocking ops
One-Sided Append in Key Exchange

![Diagram of One-Sided Append in Key Exchange]

- **PE**
- **N**
- **dst_buf**
- **Counter**
- **PE 0**
- **PE 1**
SHMEM_PUSH Interface

/* SHMEM Offset Counter (OCT) object management (collective) */
void shmem_oct_create(shmem_oct_t *oct, void *buffer, size_t len);
void shmem_oct_destroy(shmem_oct_t *oct);

/* Appending put, a.k.a. “push”, one-sided communication */
void shmem_push(shmem_oct_t oct, const void *src_buffer,
               size_t len, int pe);

/* Offset counter update/query routines (local) */
void shmem_oct_reset(shmem_oct_t oct);
size_t shmem_oct_get(shmem_oct_t oct);

Push: One-sided operation appends sender’s data to receiver’s buffer
Introduces “offset counter”, which is atomically updated during push
Can be used in conjunction with other proposed extensions:
  - Contexts, counting puts, nonblocking communication, …
Sender vs. Receiver-Managed Approach

Fetch-add (a) implementation has a data dependency at the sender

- Takes a network round-trip to resolve

Receiver-managed implementation is “fire-and-forget”

- Utilized “agent” (hardware/software) at receiver side to calculate dest. location
NAS IS Key Exchange (Push)

```c
int dst_buf[DST_BUF_SIZE]; /* Symmetric buffer for RX of keys */
shmem_oct_create(&keys_oct, dst_buf, DST_BUF_SIZE);
...
for (i = 0; i < num_pes; i++) {
    shmem_int_push(keys_oct, src_buf+src_off[i], cnt[i], i);
}
...
shmem_oct_free(&keys_oct);
```

Key-exchange portion of integer bucket sort algorithm

Destination buffer addressed using the offset counter (OCT)

- Allows receiver-managed implementation
- Receiver can calculate effective target address

Sidebar: Iterations can be overlapped with nonblocking ops
Implementation of SHMEM_PUSH

Can be implemented on top of OpenSHMEM 1.1
- Symmetric integer used as offset counter (OCT)
- Fetch-add of OCT followed by put

Implementation on Portals 4
1. Append buffer as new match entry (ME) on OCT match list
2. Match bits are selected to globally and uniquely identify the append buffer
3. Set locally managed offset flag on ME (PTL_ME_MANAGE LOCAL)
4. Portals counter attached to ME to expose Portals offset counter
Early Perf. Evaluation of Key Exchange

InfiniBand® Cluster: 16 nodes, 16 PEs; OpenSHMEM over Portals 4 over IB
Drop-off at Portals \textit{max\_volatile\_size} (buffering converts blocking to NB)
Concluding Discussion

Proposed SHMEM_PUSH extension

- Can accelerate appending data to a remote buffer
- Enables runtime designers to optimize comm. pattern
  - E.g. through a receiver-managed implementation

Discuss synchronization: How do users consume this data?

- Offset counter tells us next free location
  - Does not guarantee that data has arrived
- Can combine with counting puts variation that counts bytes
  - Waiting for offset and received-bytes to match guarantees completion
- Currently, programmers would use barrier or flag variables

Discuss: Can this be done efficiently in MPI?

- Probe followed by receive or fetch-add and put