libvmemcache

Problem statement

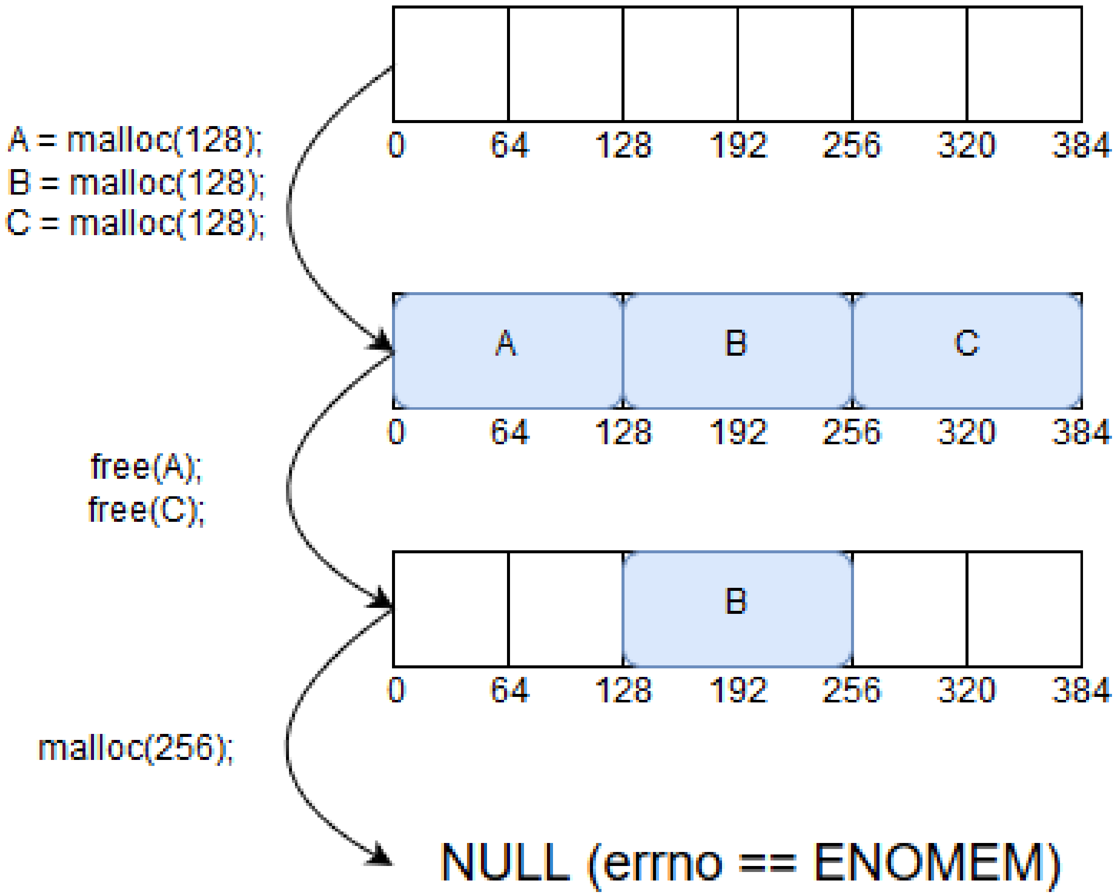
- Local LRU cache
- Support for large capacities available with persistent memory (many terabytes per server)
- Lightweight, efficient and embeddable
- In-memory
- Scalable

Existing solutions

- In-memory databases tend to rely on malloc() in some form for allocating memory for entries
  - Which means allocating anonymous memory
- Persistent Memory is exposed by the operating system through normal file-system operations
  - Which means allocating byte-addressable PMEM needs to use file memory mapping (fsdax).
- We could modify the allocator of an existing in-memory database and be done with it, right? ☺

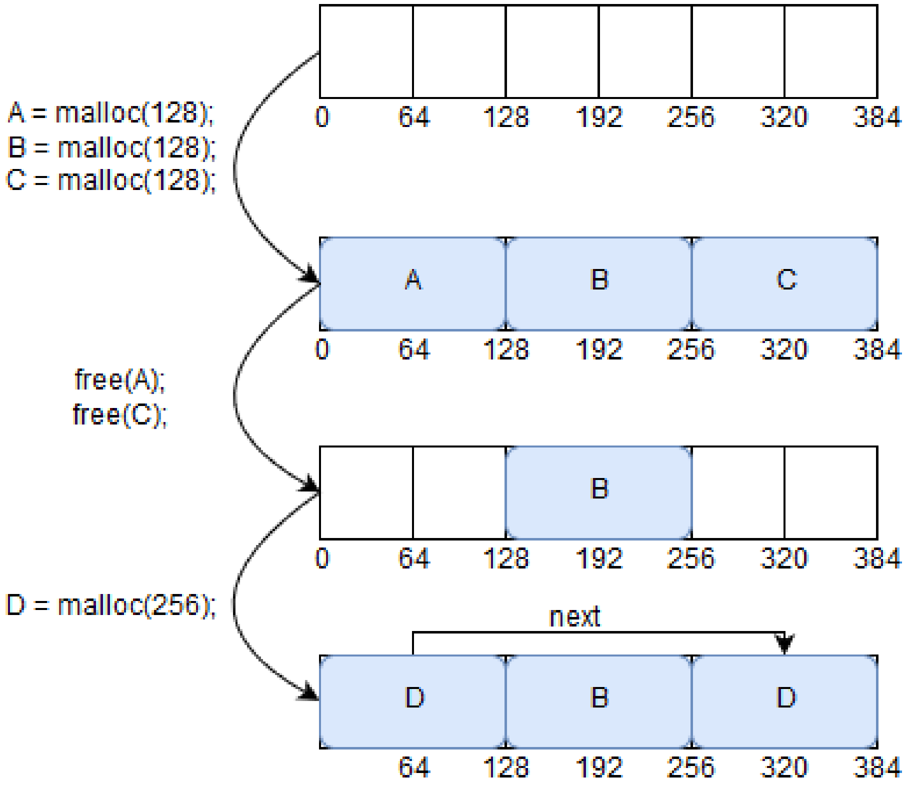
Fragmentation

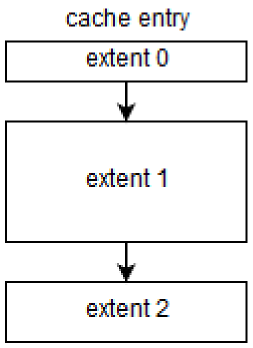
- Manual dynamic memory management a'la dlmalloc/jemalloc/tcmalloc/palloc causes fragmentation
- Applications with substantial expected runtime durations need a way to combat this problem
    - Compacting GC (Java, .NET)
    - Defragmentation (Redis, Apache Ignite)
    - Slab allocation (memcached)
- Especially so if there's substantial expected variety in allocated sizes



Extent allocation

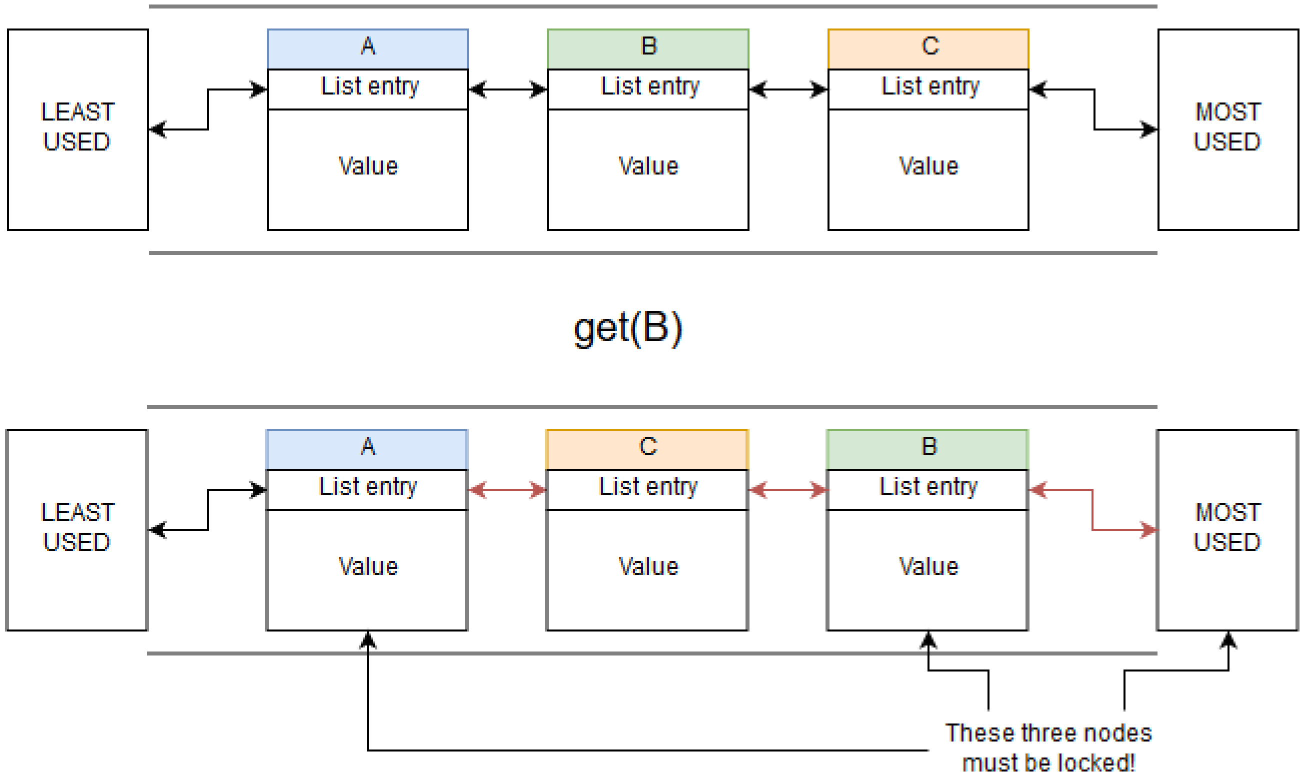
- If fragmentation is unavoidable, and defragmentation/compacting is CPU and memory bandwidth intensive, let’s embrace it!
- Usually only done in relatively large blocks in file-systems.
- But on PMEM, we are no longer restricted by large transfer units (sectors, pages etc)





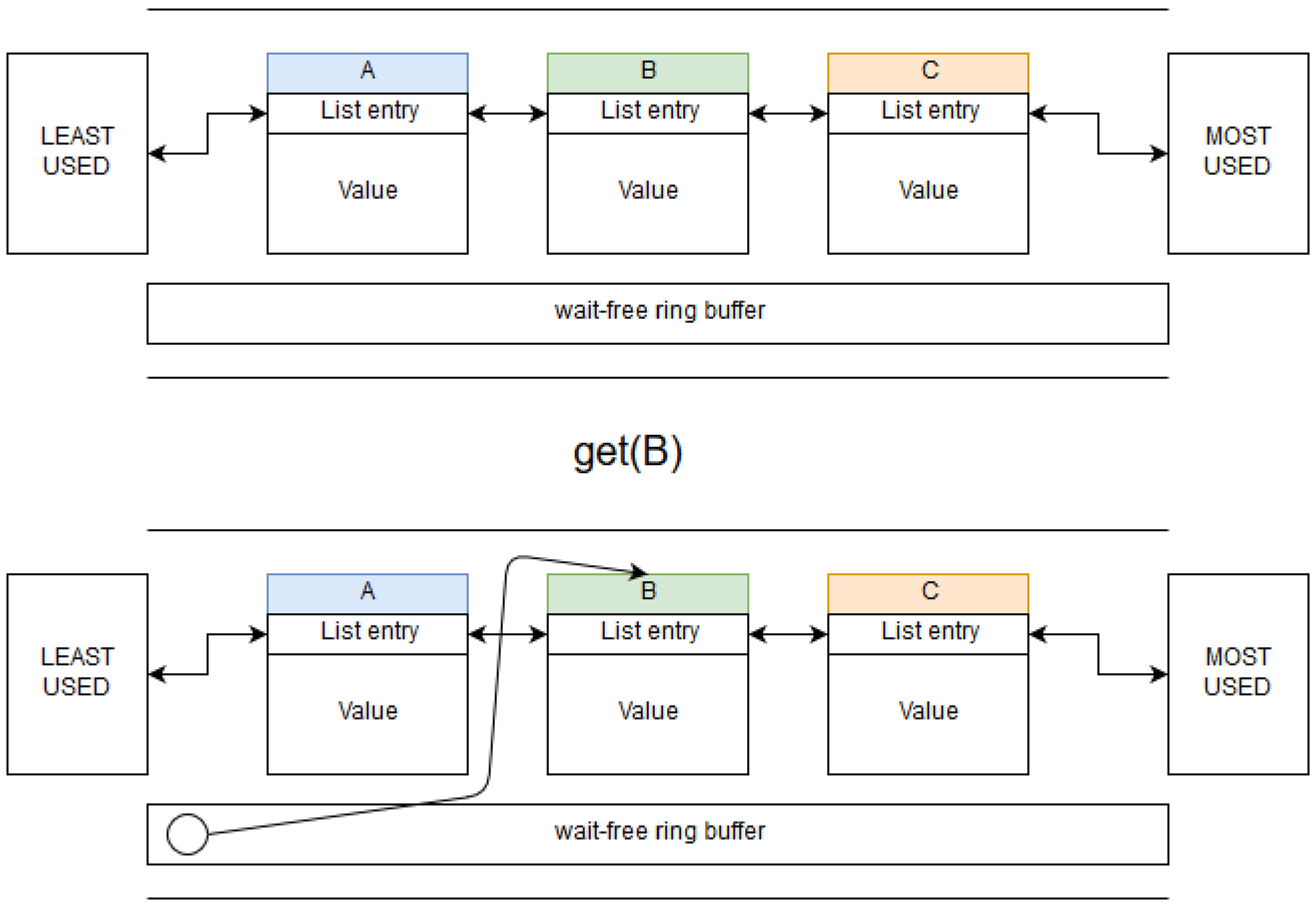
Scalable replacement policy

- Performance of libvmemcache was bottlenecked by naïve implementation of LRU based on a doubly-linked list.
- With 100st of threads, most of the time of any request was spent
  waiting on a list lock…
- Locking per-node doesn’t solve the problem…



Buffered LRU

- Our solution was quite simple.
- We've added a wait-free ringbuffer which buffers the list-move operations
- This way, the list only needs to get locked during eviction or when the ringbuffer is full.



Lightweight, embeddable, in-memory caching

```
VMEMcache *cache = vmemcache_new("/tmp", VMEMCACHE_MIN_POOL,
VMEMCACHE_MIN_EXTENT, VMEMCACHE_REPLACEMENT_LRU);

const char *key = "foo";
vmemcache_put(cache, key, strlen(key), "bar", sizeof("bar"));

char buf[128];
ssize_t len = vmemcache_get(cache, key, strlen(key),
       buf, sizeof(buf), 0, NULL);

vmemcache_delete(cache);
```

libvmemcache has normal get/put APIs, optional replacement policy, and configurable extent size
Works with terabyte-sized in-memory workloads without a sweat, with very high space utilization.
Also works on regular DRAM.

https://github.com/pmem/vmemcache

Thanks!

Questions?