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**Scientific Computing 1**  
**Handout 8**  
**November 27, 2018**

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## Memory Architecture and Memory Management

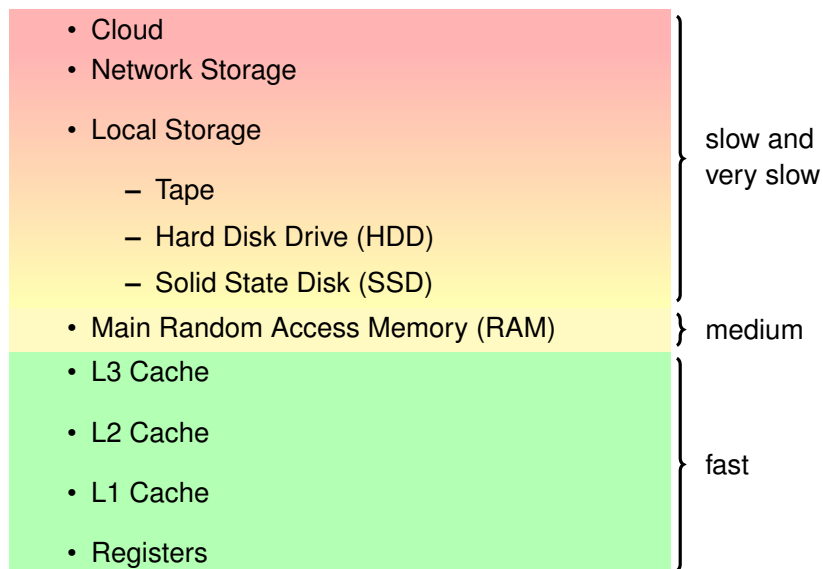


Figure 1: Memory Classes in Scientific Computing

- Operating system provides one abstract **virtual memory** to disguise local data storage (RAM, HDD, SSD) and fragmentation from users.
- virtual memory arranged in **separate virtual address spaces** for all process.
- smallest memory unit is a **page** of at least 4k Bytes.
- by default data can be anywhere in a page. **Page aligned** memory guarantees data to start at page start. **Page locked** memory can not be swapped.
- Processes trying to access data in foreign address spaces are aborted by a `SIGSEGV`. Processes that access symbols from a shared object library that was replace during their operation inaccurately cause abortion by `SIGBUS`, the bus error signal.

**Cache** very fast small memory portion that is especially close to processing units.

**L1** closest to processing units. Separated for instructions and data. Arranged per processor core

**L2** Larger, but shared by data and instructions. Also available per processor core.

**L3** Largest of the three. Connects to main memory. Shared by all cores of the processor.

**Main Memory** The general purpose volatile storage system. Operates at average speed.

**Local Storage** Rather slow and should be used for **double buffering**, i.e., caching of unused data to slower memory to free up main memory for temporary data.

**Network Storage and Cloud Space** Mainly useful for storing final data. The exception are Infiniband Server Network storage systems that operate at similar speed as local disks.

**Secret of a fast method: program and data locality**