Crossing the Chasm: Sneaking a Parallel File System into Hadoop

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Overview

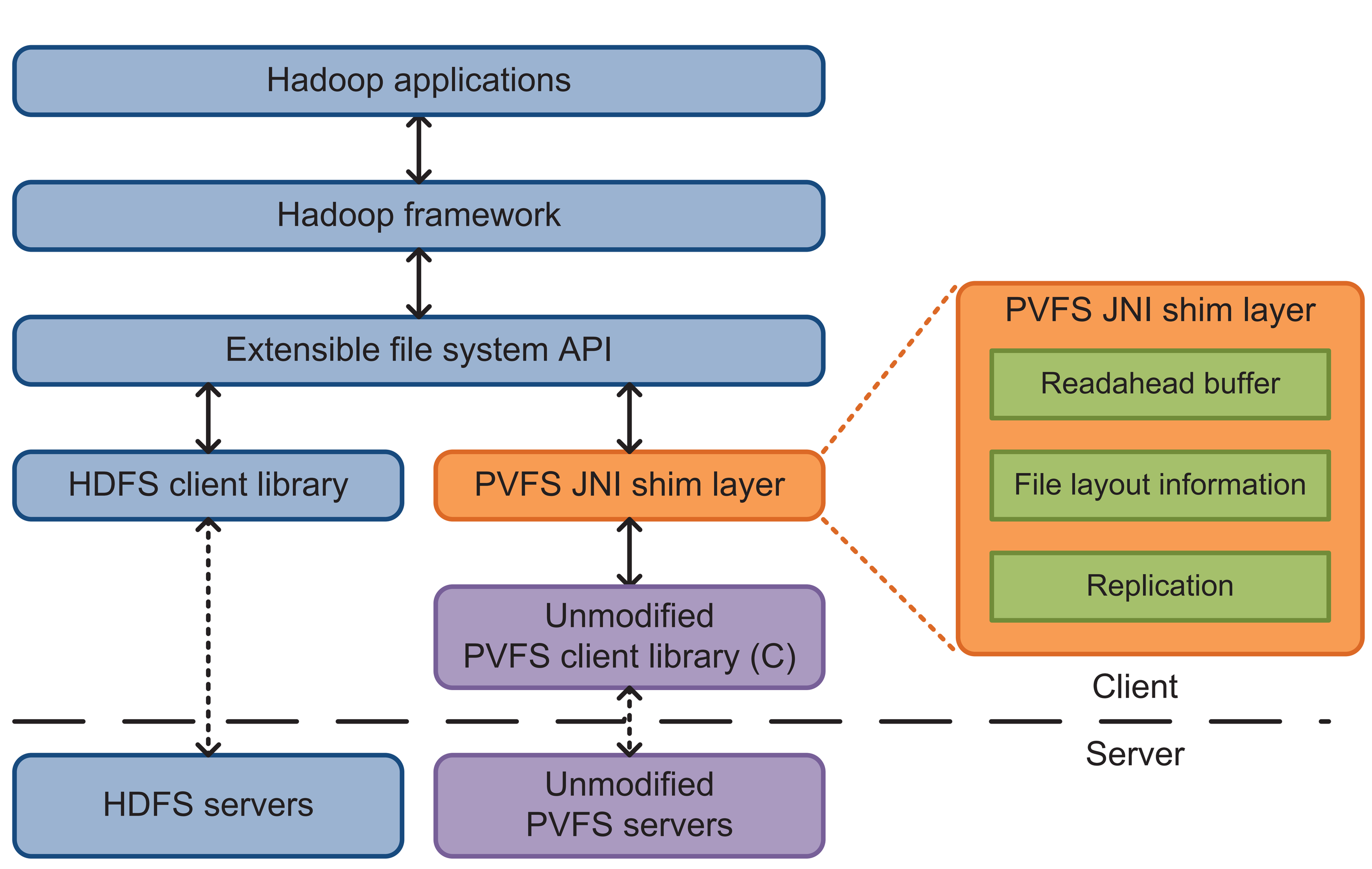
Internet Services

- Applications are becoming data-intentive
  - Large input data set (e.g. the entire web)
  - Distributed, parallel execution
- Distributed file system is a key component of the computing system
  - Purpose-built for anticipated workloads
  - New, diverse semantics (typically not support POSIX)
- Hadoop & Hadoop distributed file system (HDFS)
  - Distribute data across multiple nodes
  - Use triplication for reliability
  - Divide application into many small units of work
  - Use file layout information, which shows where data is located, to collocate computation and data

High performance computing (HPC)

- Equally large scale applications
  - Large input data set (e.g. astronomy data)
  - Distributed, parallel execution
  - Use parallel file systems for scalable I/O
- Parallel file system
  - Handle a wide variety of workload
    - Concurrent reads and writes
    - Small file support, scalable metadata
  - Typically support POSIX and VFS interface
  - Maturing and being standardized (pNFS)

PVFS plug-in under Hadoop stack

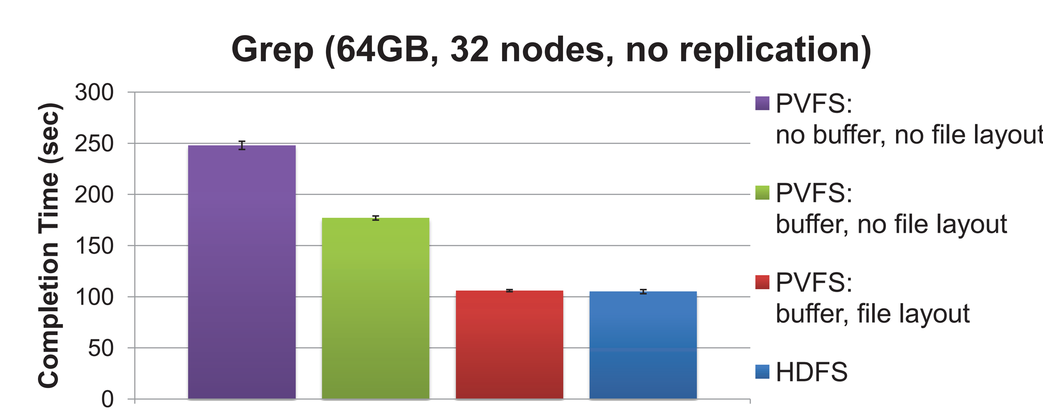


- Readahead buffer: reads 4MB from PVFS and replies in 4KB units to Hadoop
- File layout information: exposes file layout stored in PVFS as extended attributes
- Replication: triplicates write request to three PVFS files with disjoint layouts

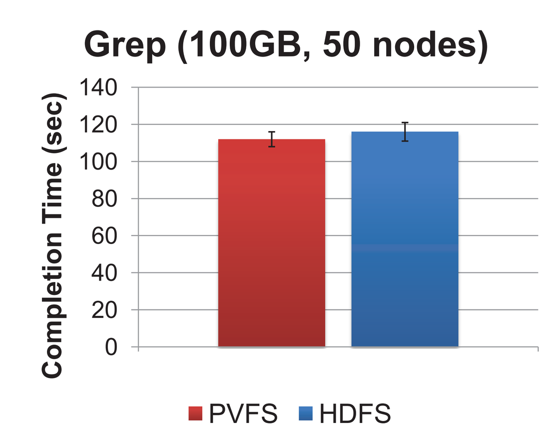
Experiment Setup

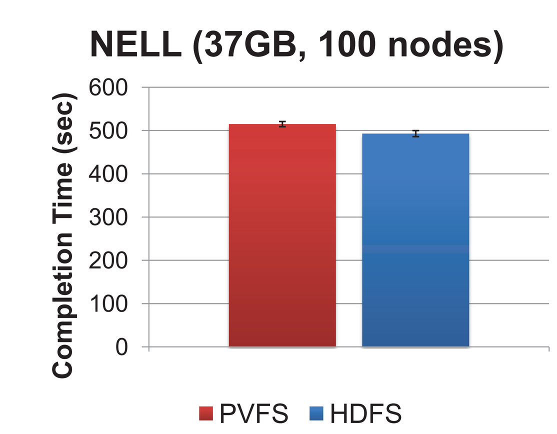
- Yahoo! M45 cluster (Xeon quad-core 1.86 GHz, 6GB Memory, 7200 rpm SATA 750 GB disks, Gigabit Ethernet)
- Benchmarks
  - Grep: Search for a rare pattern in a hundred million 100-byte records (100GB)
  - Sort: Sort a hundred million 100-byte records (100GB)
  - Never-Ending Language Learning (NELL): (from J. Betteridge) Count the number of selected phases in 37GB data-set

Experiment Results

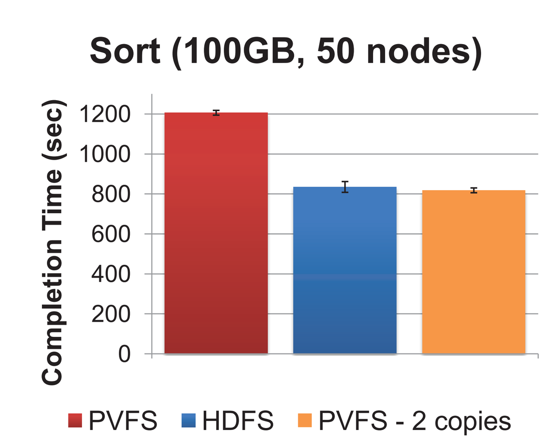


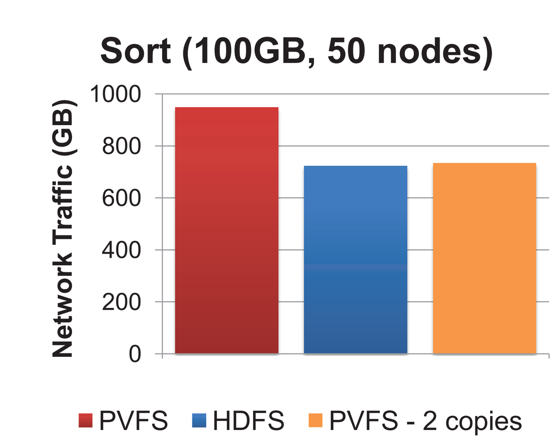
- By using both readahead buffer and file layout information, PVFS performance is comparable to HDFS





- PVFS performance is comparable to HDFS for both read-intensive applications





- *sort* using HDFS is faster than running *sort* on PVFS because HDFS writes the first copy locally

Conclusion

- With few modification in a non-intrusive PVFS shim layer, PVFS delivers promising performance for Hadoop applications
- File layout information is essential for Hadoop to collocate computation and data

Acknowledgements

- Sams Lang, Rob Ross, Yahoo!, Julio Lopez, Justin Betteridge, Le Zhao, Jamie Callan, Shay Cohen, Noah Smith, U Kang and Christos Faloutsos

Carnegie Mellon

Parallel Data Laboratory