Data Aware Caching for Big-Data Applications Using MapReduce

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Outline

- MapReduce and big-data
- Cache description
- Protocol
  - Relationship between job types and cache organization
  - Cache item submission
  - Lifetime management of cache item
  - Cache request and reply
- Experiment results
- Conclusion

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MapReduce

- MR is a simple model of distributed parallel computing
  - Capture the data parallelism and serialization in Map, Reduce, and the intermediate phases
  - Versatile and robust
- Big-data refers to the applications that work on unconventionally large amount of data
  - Large corpse of data
  - New data is generated at high rate
  - Summarizing business insights requires fast processing and low cost

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Why caching?

- Big-data requires small insights
  - A small amount of results are obtained from a huge amount of input
  - Repeating computations are expensive
  - Many processing are repetitive
    - Sorting, a sorted data split is obtained in a global sorting
    - Summary, the summary of each data split is computed
  - Processing results of data splits are generally small
    - Easy to store without too much cost
    - Some results may be large in size but save a lot of computation: sorting, data transformation.
- Caching is a great aid to the efficiency of MR

Map phase cache description

- Source data split ID + operation
  - Data file is stored in HDFS
  - Each data split is a fixed size chunk
  - Map phase operations are performed on each data split
  - The users are allowed to define their own operations
- MR's java implementation provides such interface to obtain the data split ID
- Operations need to be defined by users

Reduce phase cache description

- Unlike the Map phase, reduce phase needs the partition method to determine what data records are processed together
- Each data record has a key
  - Partition method, usually certain Hash function, computes the reducers the data record should go
  - We are not interested in what reducer the data record goes
  - Instead, we want to know what data records goes to the “same” reducer
    - We want to cache the results of the processed data from Map phase that are processed at one reducer
    - These are the results that could be reused

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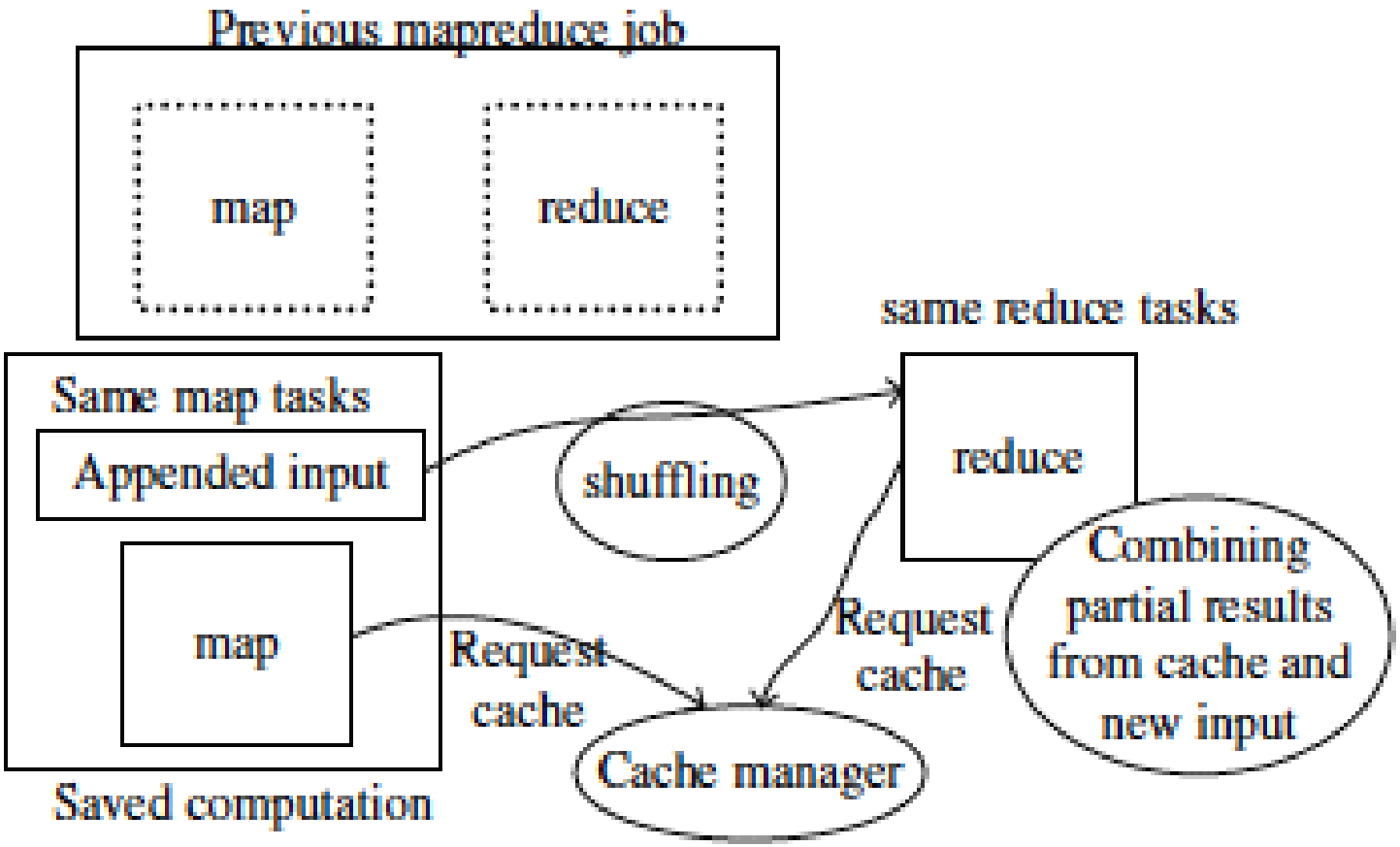
Cache request and reply



Lifetime Management

- We only consider storage cost
- Fixed Storage Quota
  - A fixed fraction of the total space used for input data is used for storing caches
- Optimal Utility
  - Consider the storage expense with the saved computation time
  - This usually can be obtained from analyzing historical jobs
    - Storage expenses can be obtained from public Cloud pricing model

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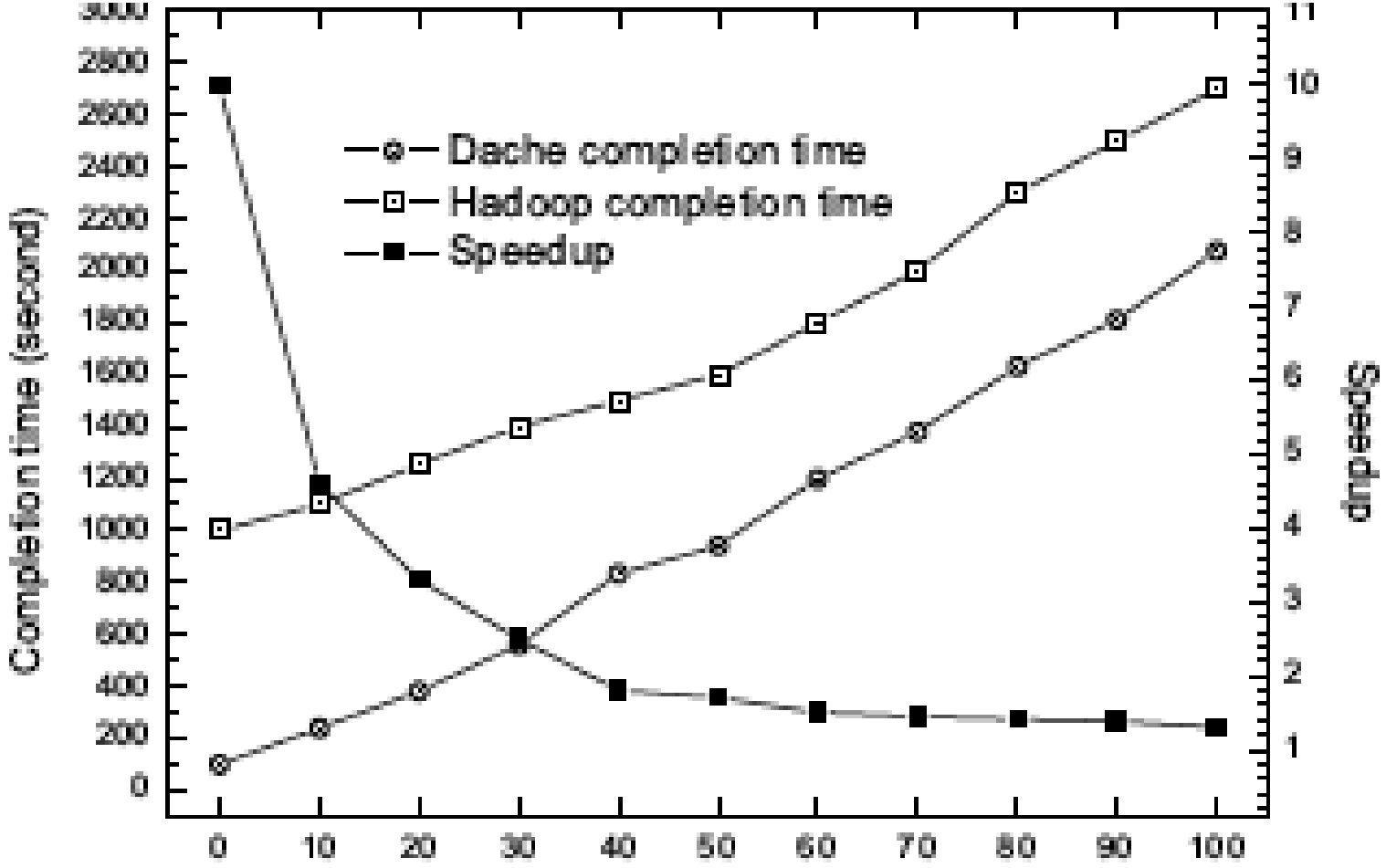
Job completion time



Conclusion

- Dache requires only a slight modification in the input format and task management of the MapReduce framework
- Testbed experiments show that it can eliminate redundant computations and saves computation time