Apache Hadoop YARN: Yet Another Resource Negotiators

Vinod Kumar Vavilapalli et al.
Hortonworks, Yahoo, Microsoft, Inmobi and Facebook

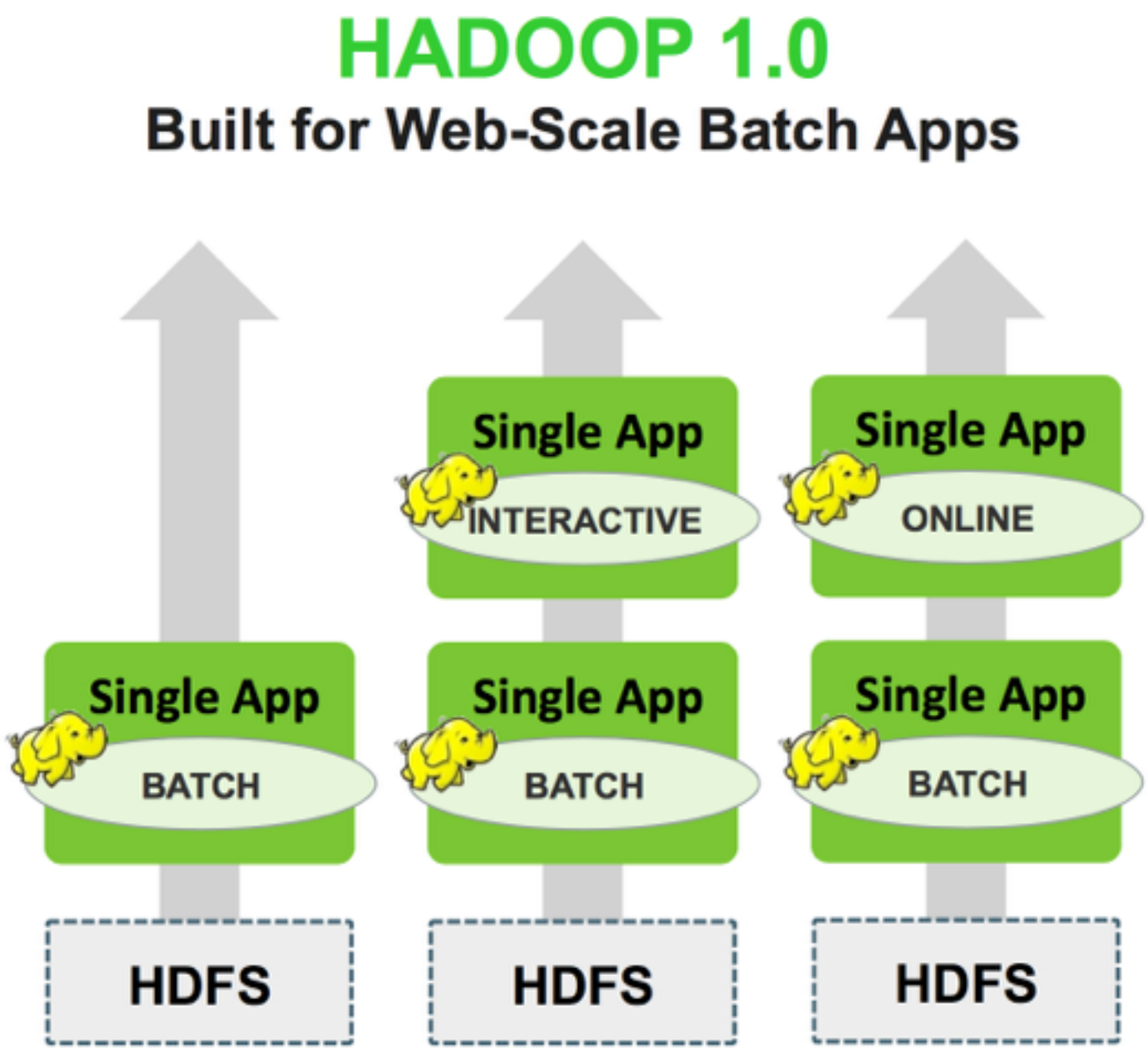
SoCC'13 Best Paper
Presenter: Hongwei Wang

Some slides are borrowed from Hortonworks and Apache Hadoop

Agenda

- Why YARN?
- YARN Architecture
- Experiments
- Conclusion

Hadoop 1.0: Batch

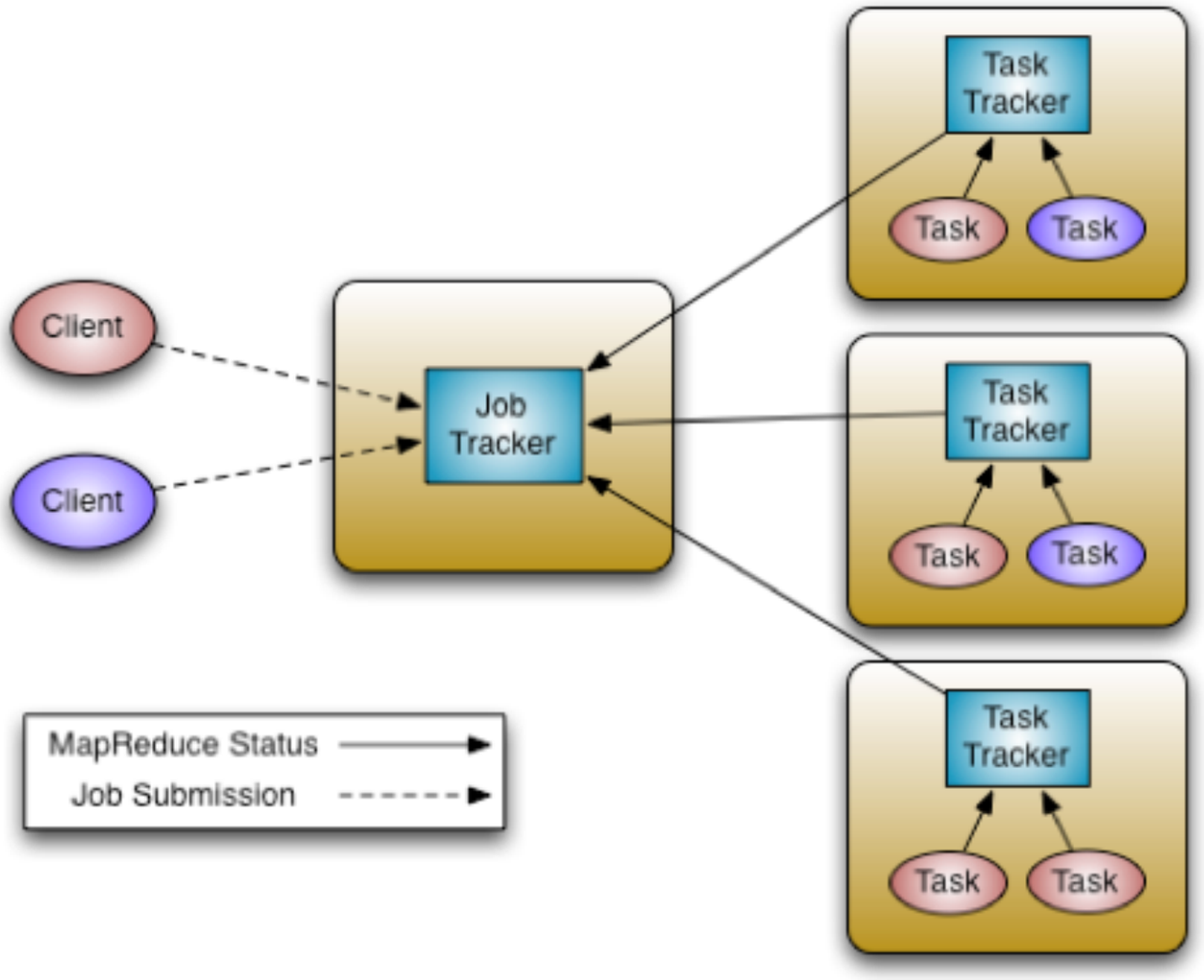


Tight coupling of MapReduce model with the resource management infrastructure

All other usage patterns must leverage the same architecture

Hadoop MapReduce Classic

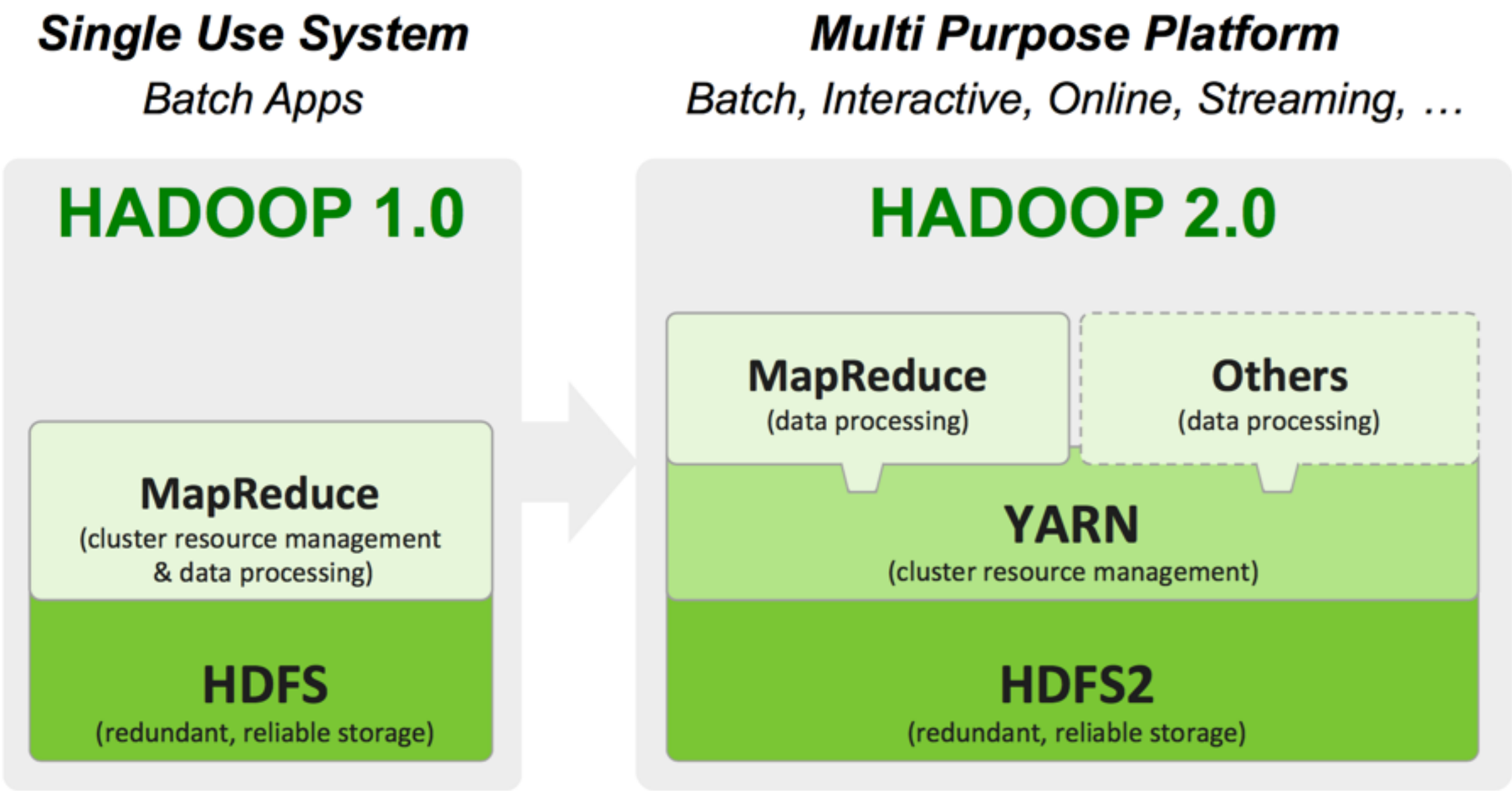
- **JobTracker**
  - Manage cluster resources
  - Job/task scheduling
- **TaskTracker**
  - Per-node agent
  - Manage tasks



MapReduce Classic: Limitations

- **Scalability**
  - Maximum cluster size: 4,000 nodes
  - Maximum concurrent tasks: 40,000
- **Overloaded JobTracker, single point of failure**
- **Hard partition of resources into map and reduce slots**
  - Low resource utilization
- **Lack support for alternative paradigms and services**
  - Iterative applications implemented using MapReduce are 10x slower

Hadoop 2: Next-Gen Platform

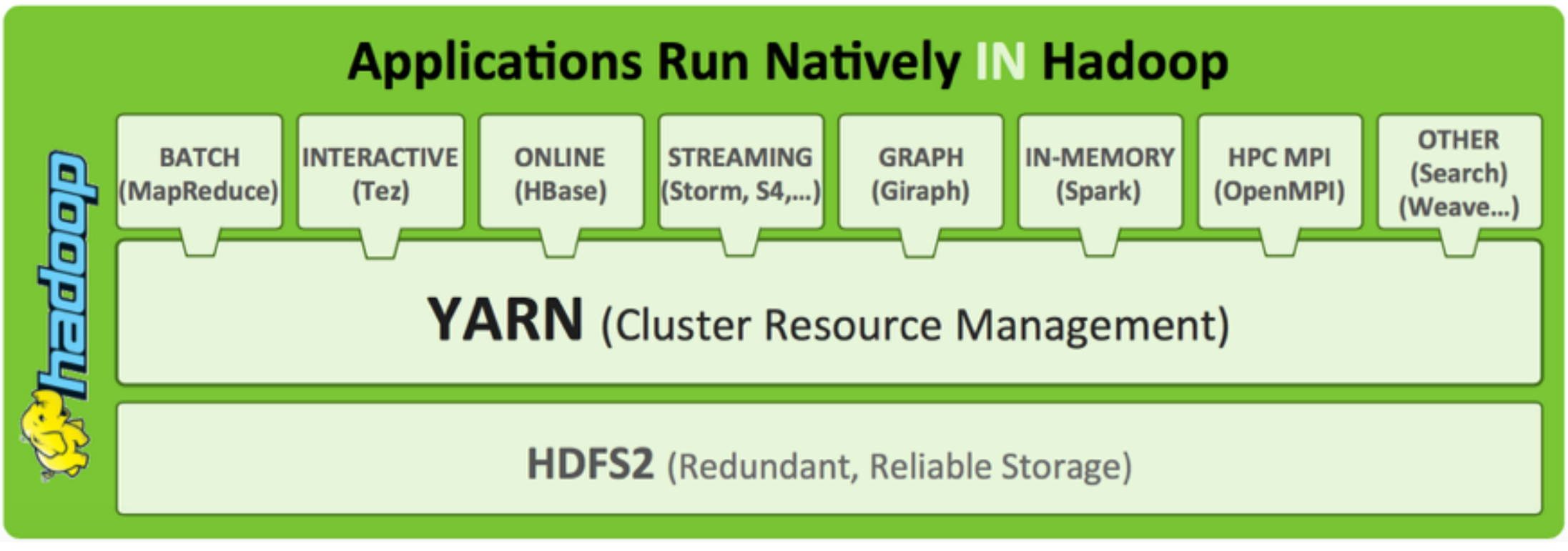


Hadoop YARN

Store ALL DATA in one place…

Interact with that data in MULTIPLE WAYS

with Predictable Performance and Quality of Service



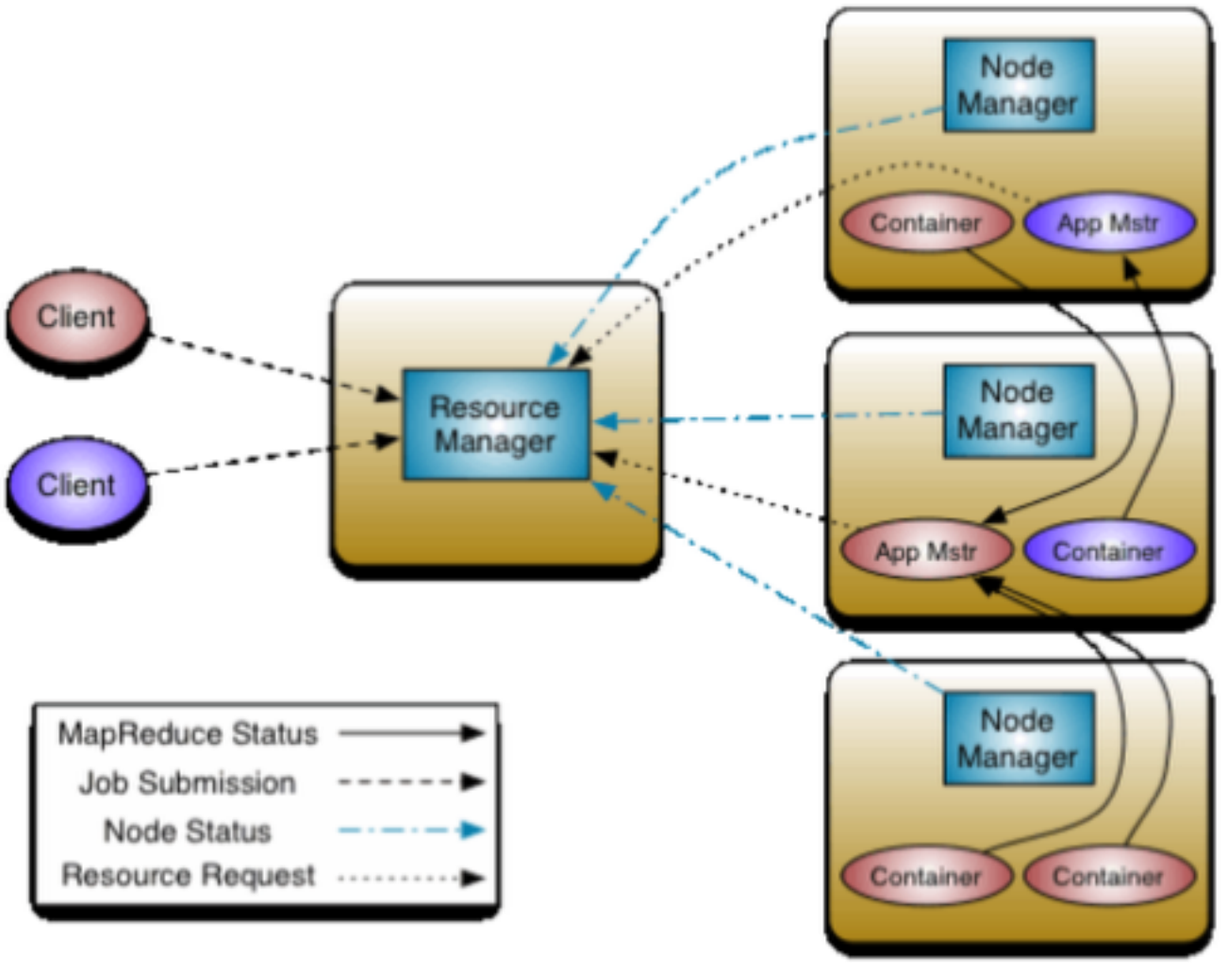
Key Improvements in YARN

- **Framework support multiple applications**
  - Decouple generic resource management from programming framework
  - Share same Hadoop cluster across applications
- **Improve cluster utilization**
  - Generic resource container replaces based fixed map/reduce slots (2 CPU, 2 GB Memory)
- **Scalability**
  - Remove complex application logic from RM to scale further

YARN Concepts

- **JobTracker is decoupled into**
  - **Resource Manager (RM):** global resource scheduler
  - **Application Master (AM):** manage per-application scheduling and task execution
- **TaskTracker is changed into**
  - **Node Manager (NM):** per-node agent, manage the life-cycle of container and monitor container resources

YARN Architecture and Workflow



1) Client -> Resource Manager

Submit App Master

2) Resource Manager -> Node Manager

Start App Master

3) Application Master -> Resource Manager

Request containers

4) Resource Manager -> Application Master

response allocated containers

5) Application Master -> Node Manager

Assign resources to tasks(assignment)

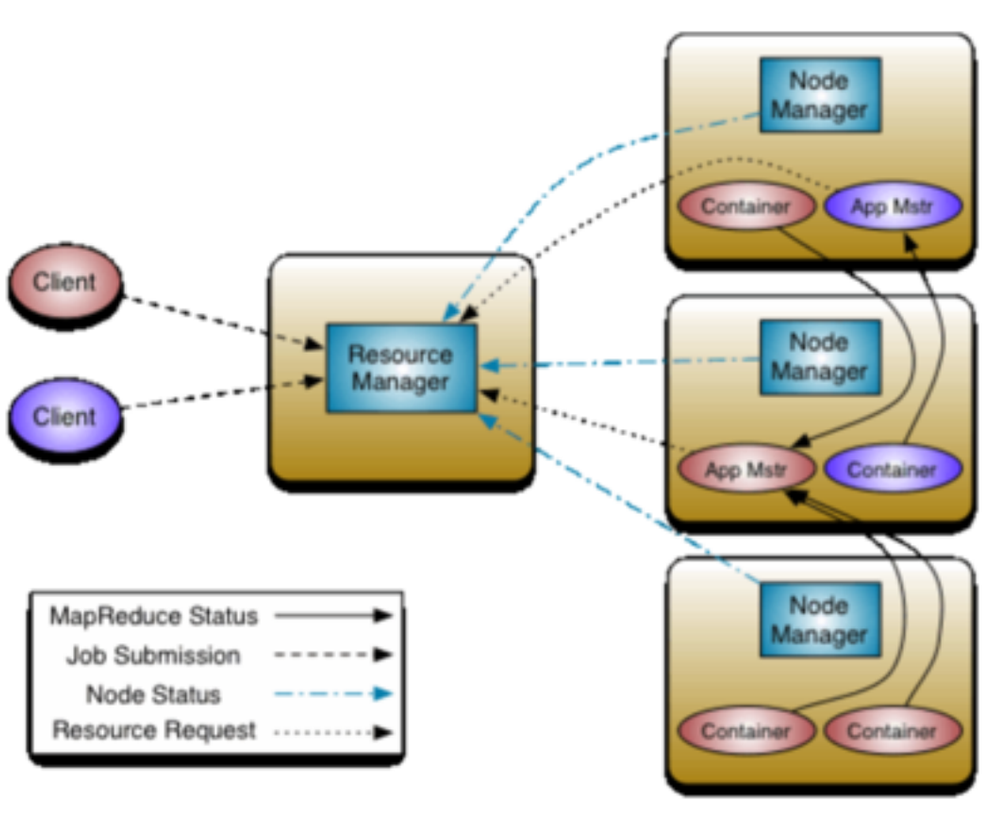
Start tasks in containers(start Container-> stop container)

6) Node Manager -> Resource Manager

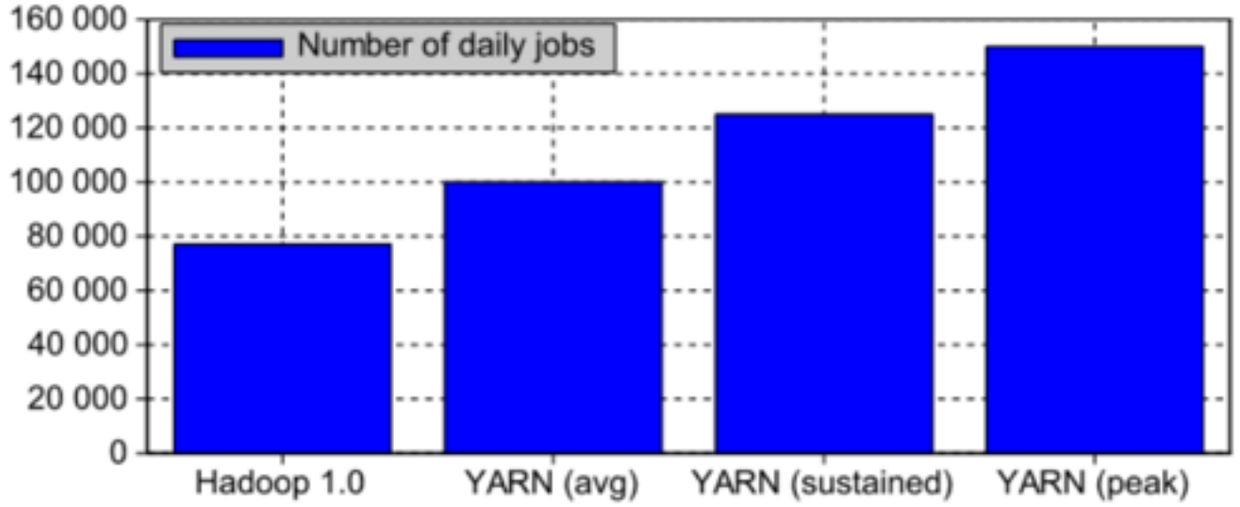
report running and *terminated container, trigger new round of scheduling.*

Fault Tolerance

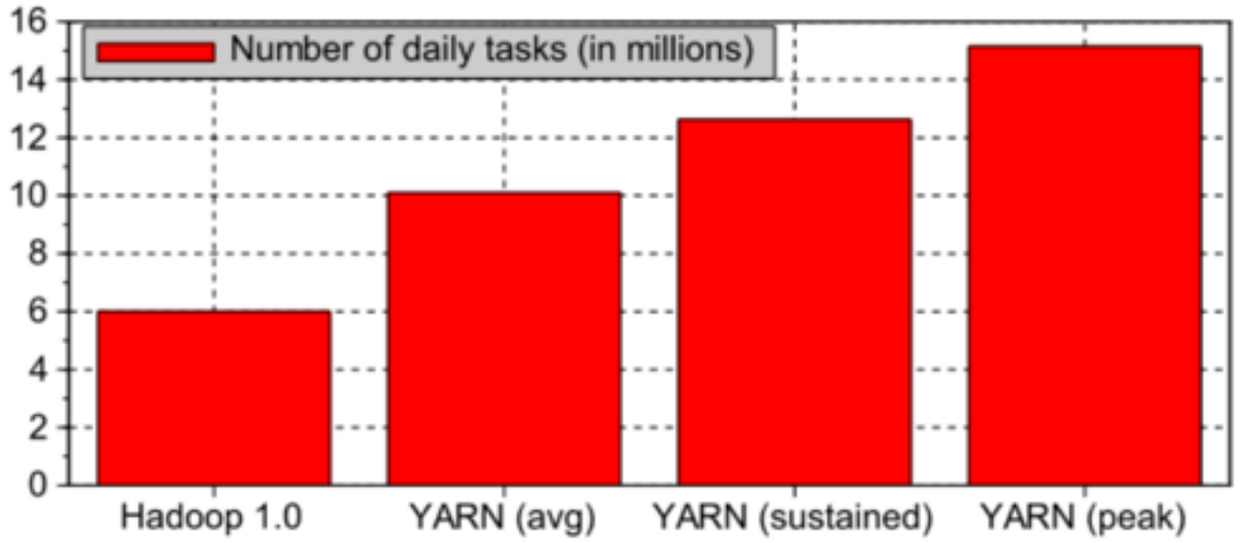
- **RM Failure**
  - Single point of failure
  - Recovery from persistent state, kill and restart all AMs
- **AM Failure**
  - AM sends periodic heartbeat to RM
  - RM will restart AM and re-run tasks
- **NM Failure**
  - NM sends periodic heartbeat to RM
  - RM marks containers as failure and report to AMs
  - AM is responsible for reacting to node failures, re-run tasks.



Experiments



(a) Daily jobs



(b) Daily tasks

Figure 2: YARN vs Hadoop 1.0 running on a 2500 nodes production grid at Yahoo!.

Conclusion

- **YARN decouples resource management and programming framework to provide**
  - Greater scalability
  - Higher utilization
  - Enable a large number of different frameworks to efficiently share a cluster
- **Cons:**
  - RM single point of failure, waste resources and time by restarting all AMs.
  - NM/AM: simple re-run failed/killed tasks leads to wastes
  - Log aggregation increases the pressure of HDFS NameNode, making it as a bottleneck