Hadoop的最新进展

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SACC2011

About me

- Hadoop Tech Leader in Baidu
- HADOOP NUMBERs in Baidu
  - Nodes: 1.5w
  - Input data/per day: > 10PB
  - Clusters: 10
  - Big Cluster: 3000 Nodes
  - ***The most busy Hadoop Clusters in the world***

Agenda

- Community - Hadoop 2.0
  - HDFS 2.0
  - MapReduce 2.0
- Baidu - Hadoop 2.0
  - Baidu - HDFS 2.0, HDFS 3.0
  - Baidu - MapReduce 2.0
- TODO
  - CloudTransfer
  - MR-Ontime(App Stability)
  - Big, Big, Big Cluster?

Community-HDFS2.0-Scalability

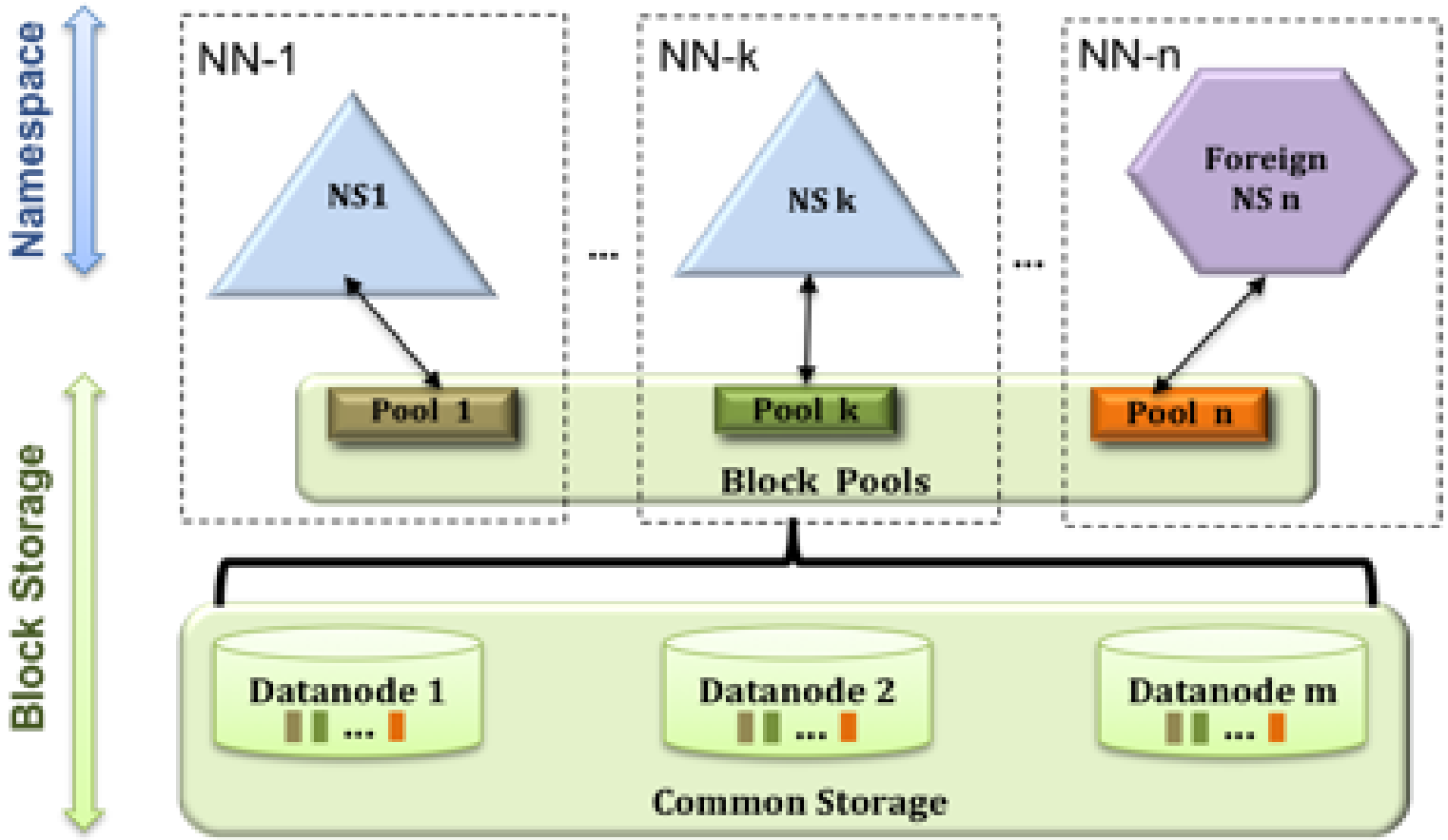
- Scalability
  - 文件数、块数
  - 负载

Cluster Summary

156146781 files and directories, 120438664 blocks = 276585445 total.
Heap Memory used 89.51 GB is 69% of Commited Heap Memory 127.95 GB. Max Heap Memory is 127.95 GB.
Non Heap Memory used 29.99 MB is 66% of Commited Non Heap Memory 45.42 MB. Max Non Heap Memory is 132 MB.

- HDFS Federation
  - 4 months
  - HDFS-1052
  - hadoop-0.23 (coming soon, 2011-11)

HDFS Federation

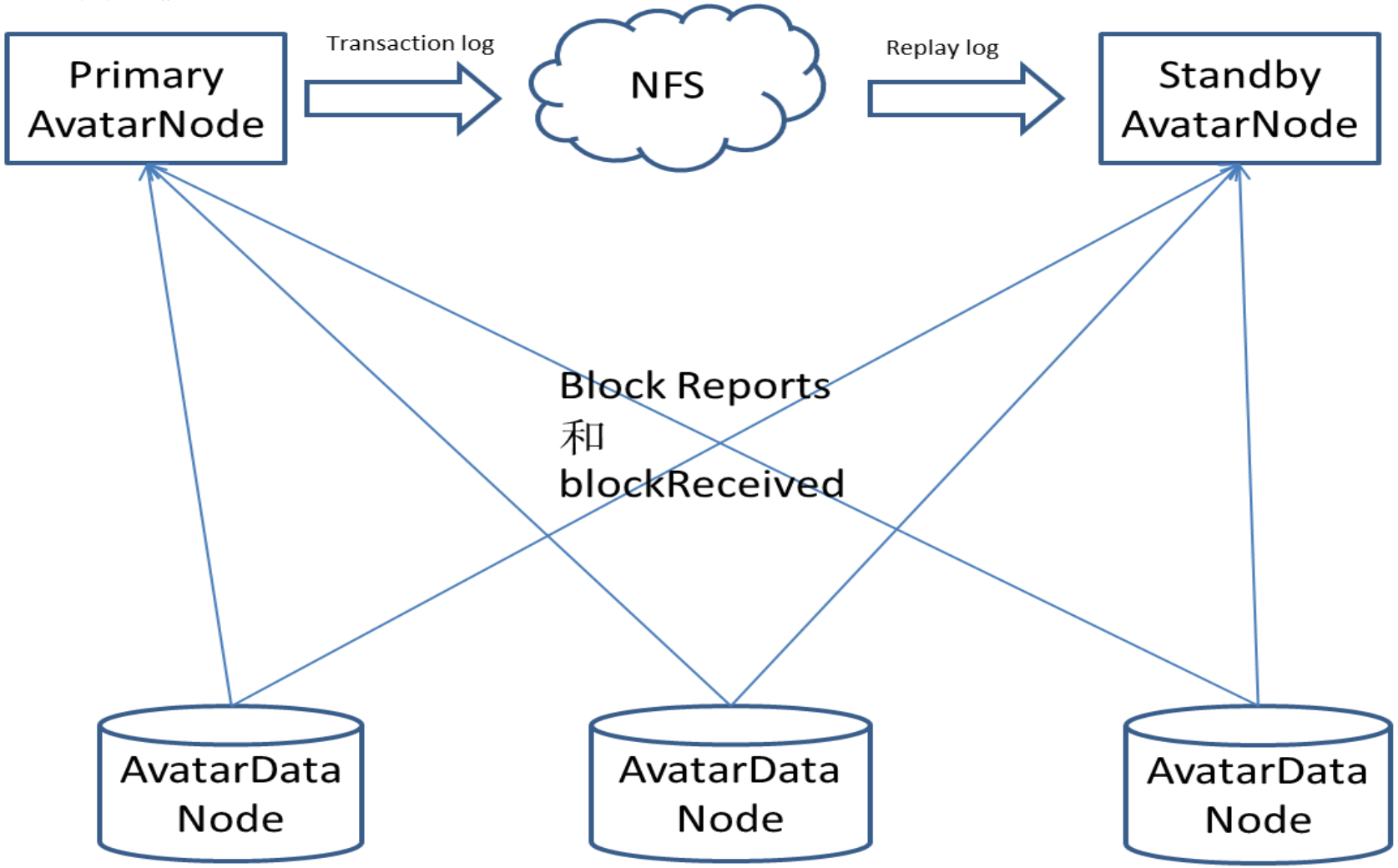


Community-HDFS2.0-Availability

- Availability
  - NameNode单点
  - 1.5亿文件+1.5亿块+2000节点：重启花费40分钟
- Avatar NameNode
- Backup NameNode

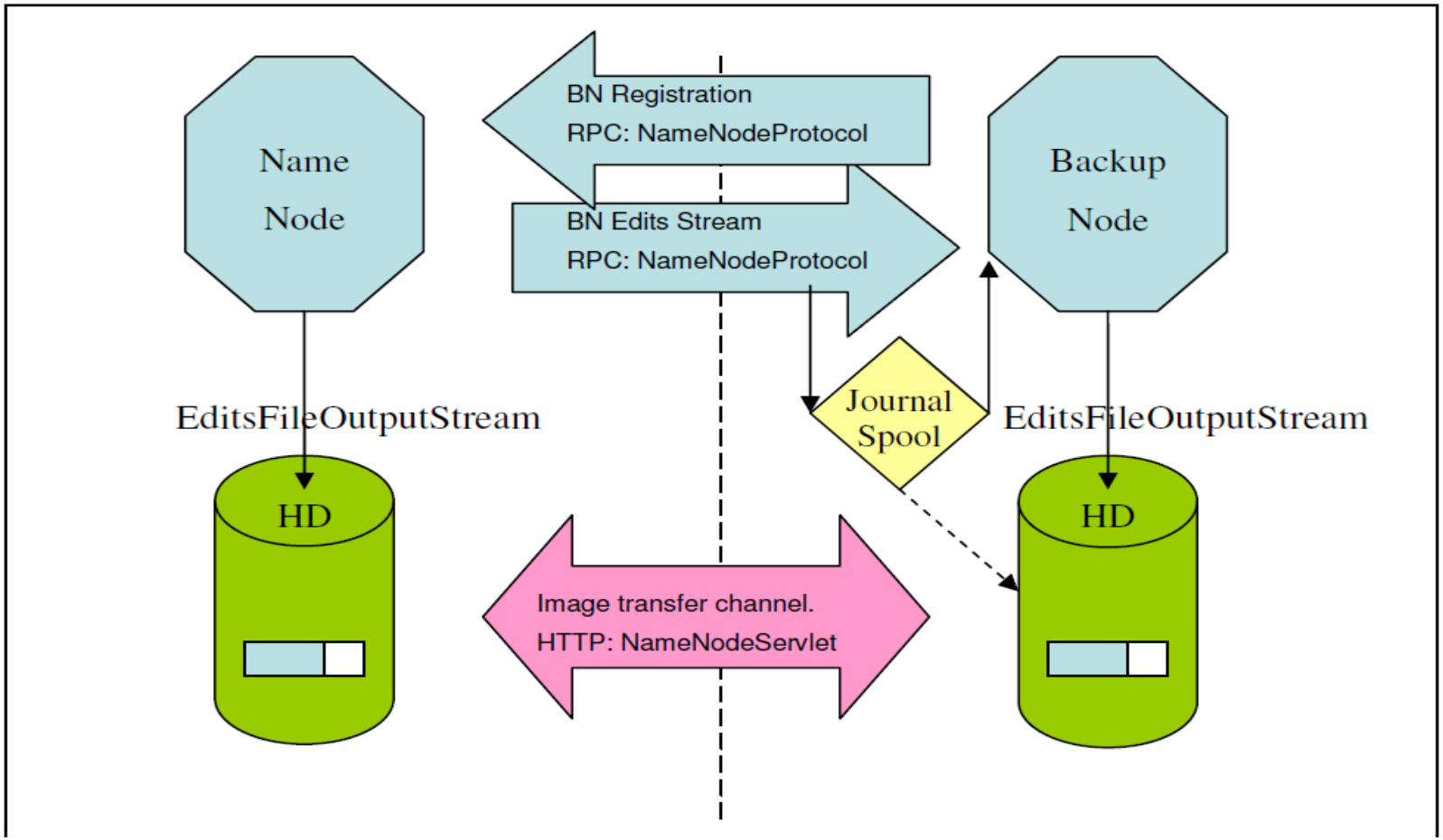
Facebook-Avatar NameNode架构

1. *NetApp Filer: 100w*
2. *VIP – 同网段*



社区-Backup NameNode架构

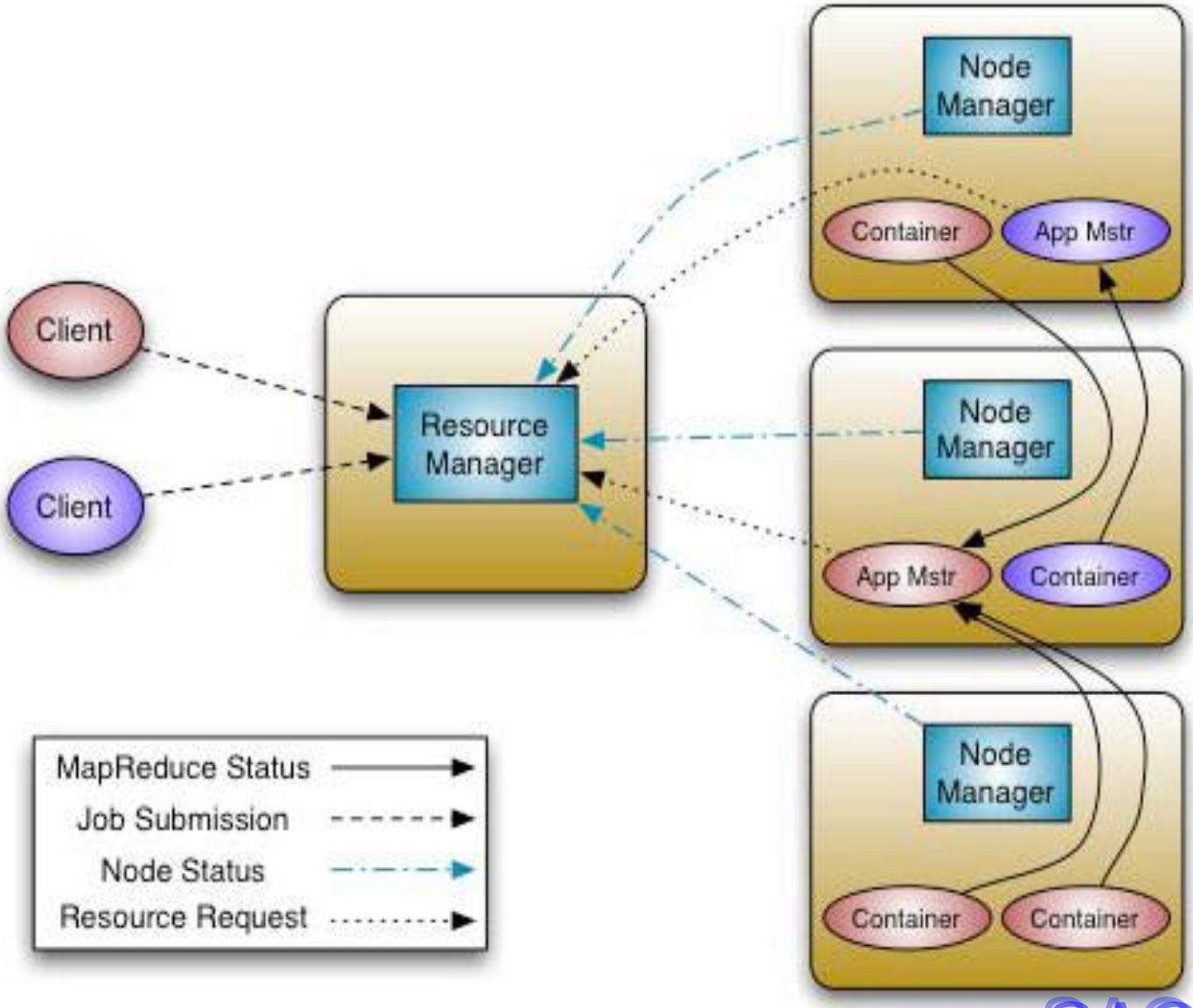
1. 复杂
2. Backup Node的问题可能造成服务不稳定



- MapR - HDFS

Community-MR2.0

- Next MapReduce (MapReduce 2.0)
  - Scalability
    - Cluster resouce management
    - Application lifecycle management
  - Utilization
    - cpu, memory, io, network
    - remove fixed partition of map and reduce slots
  - Support for programming paradigms other than MR
    - MPI
    - Multi-version Hadoop
    - Spark
    - ……
- 100人月， hadoop-0.23

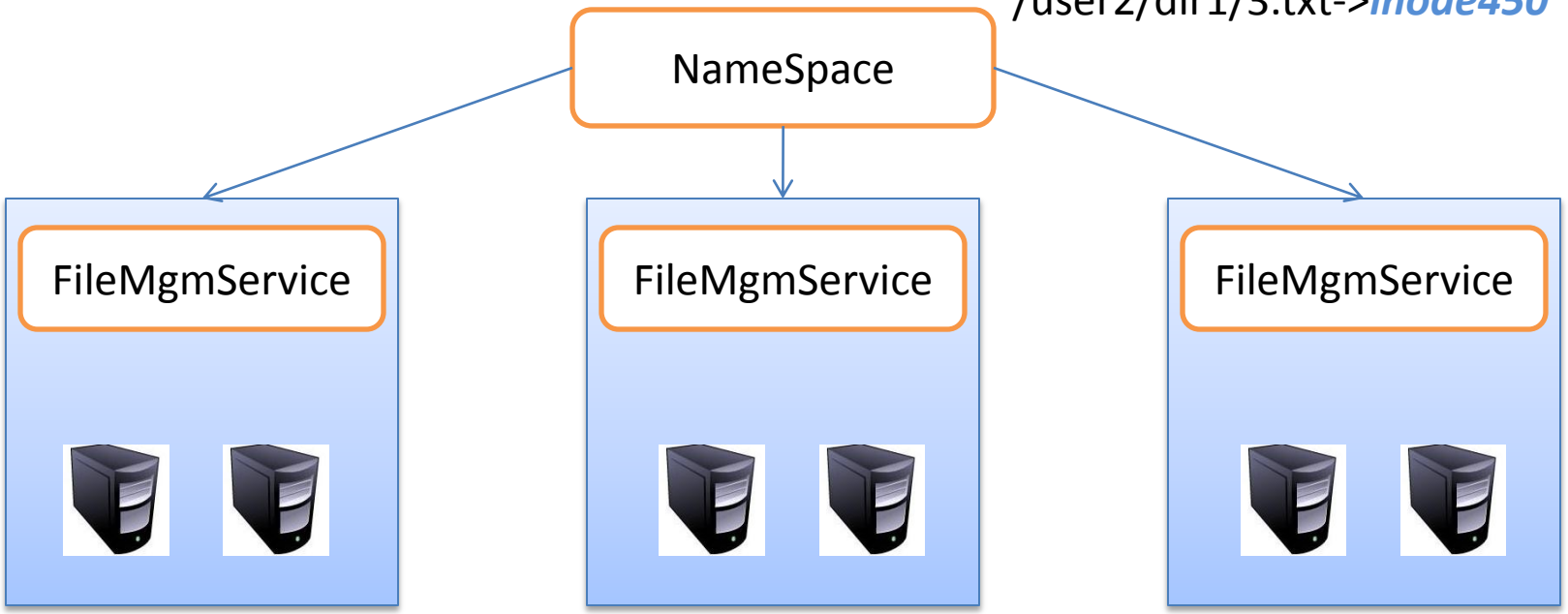

Client
Client
Resource Manager
Node Manager
Container
App Mstr
Node Manager
App Mstr
Container
Node Manager
Container
Container
MapReduce Status
Job Submission
Node Status
Resource Request

Baidu-HDFS2-Scalability

- 3kw个文件，3kw个块
  - 块管理≈ 7.8G，包括全部块副本信息
  - 目录树≈ 4.3G，目录层次结构，包含文件块列表信息
- 到10亿文件、10亿块的数据规模
  - 块管理≈ 240GB
  - 目录树≈ 140GB
- 负载
  - 集群规模扩大后，单点的NameNode请求压力也会同时增大

Baidu-hdfs2-architecture

/user1/1.txt -> ***inode120***
/user2/2.txt -> ***inode231***
/user2/dir1/3.txt->***inode450***



inode120->
user,group, rwxr-x---, size, repl
blkX, blkY, blkZ
inode450->
user,group, rwxr-x---, size, repl
blkX, blkY, blkZ

inode231 -> xxxxxx

inodexxx -> xxxxxx

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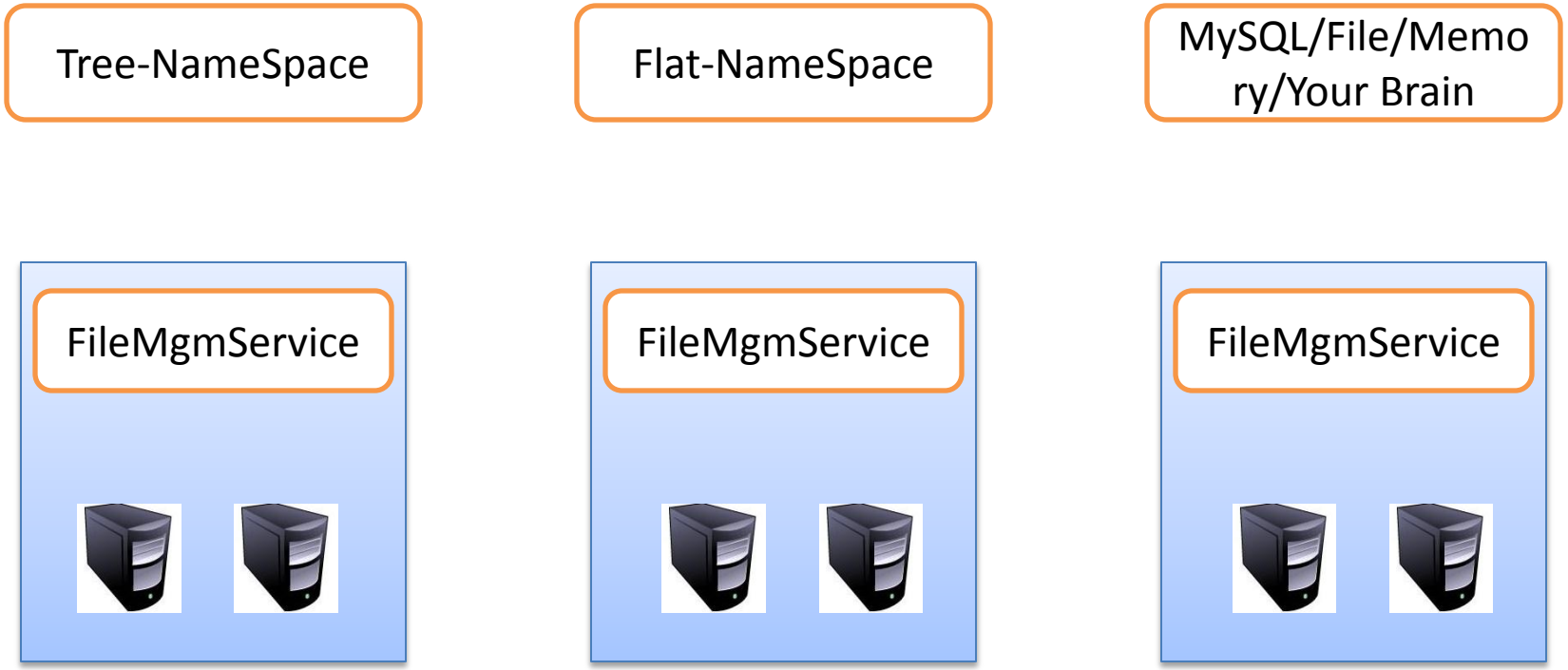
支持各类名字空间

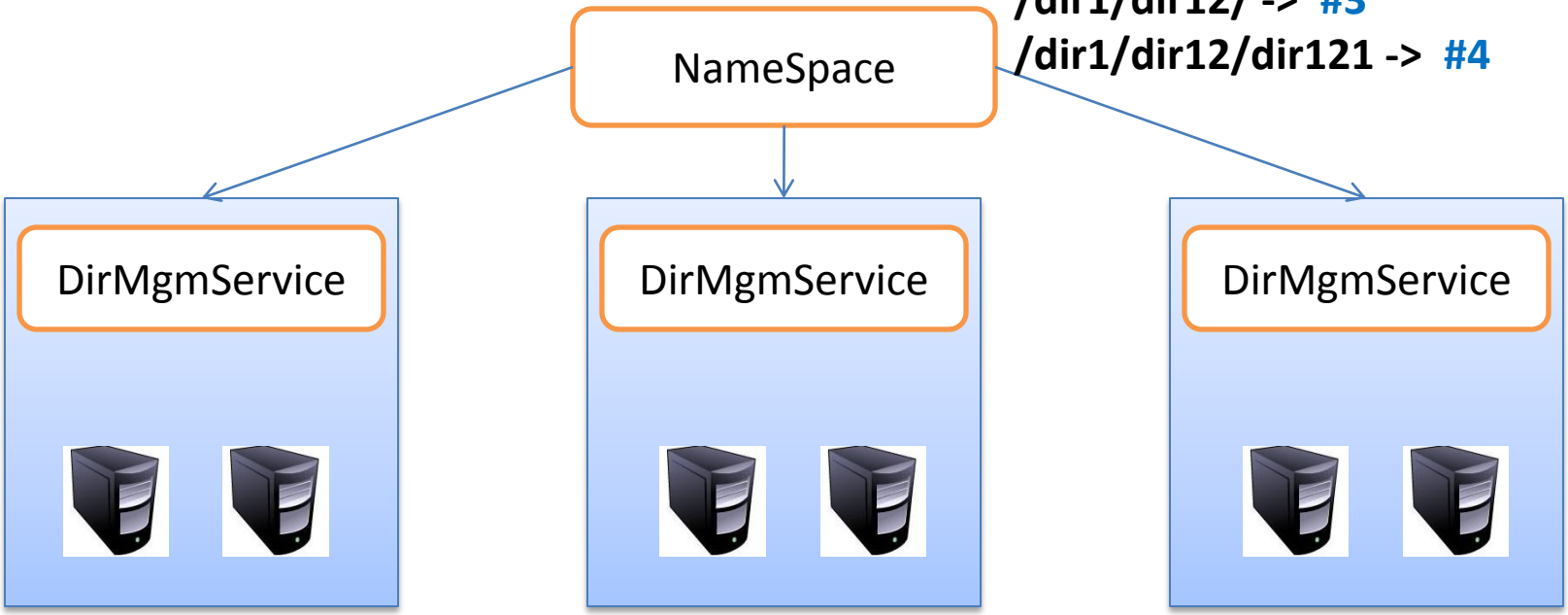

Tree-NameSpace
Flat-NameSpace
MySQL/File/Memory/Your Brain
FileMgmService
FileMgmService
FileMgmService

- HDFS2
  - 内存: 10亿文件，10亿块
    - Namespace：66GB文件数据 + 1GB目录
    - 单节点就可以管理
  - 请求负载:
    - 大部分耗时操作都属于文件对象管理层，不用经过Namespace
    - 最耗CPU资源的若干操作中，仍需经过Namespace的只占13.7%
    - 命名空间管理不再维护块信息，大部分操作都不需要加全局锁，可以更充分利用CPU资源

Baidu-hdfs3-architecture (?, 如有必要)

1) File可以rename, 但是不能在目录间移动
2) Dir可以mv
3) 文件数能力可以支撑到100亿到200亿，负载继续下移

/dir1/ -> #1
/dir1/dir11/ -> #2
/dir1/dir12/ -> #3
/dir1/dir12/dir121 -> #4

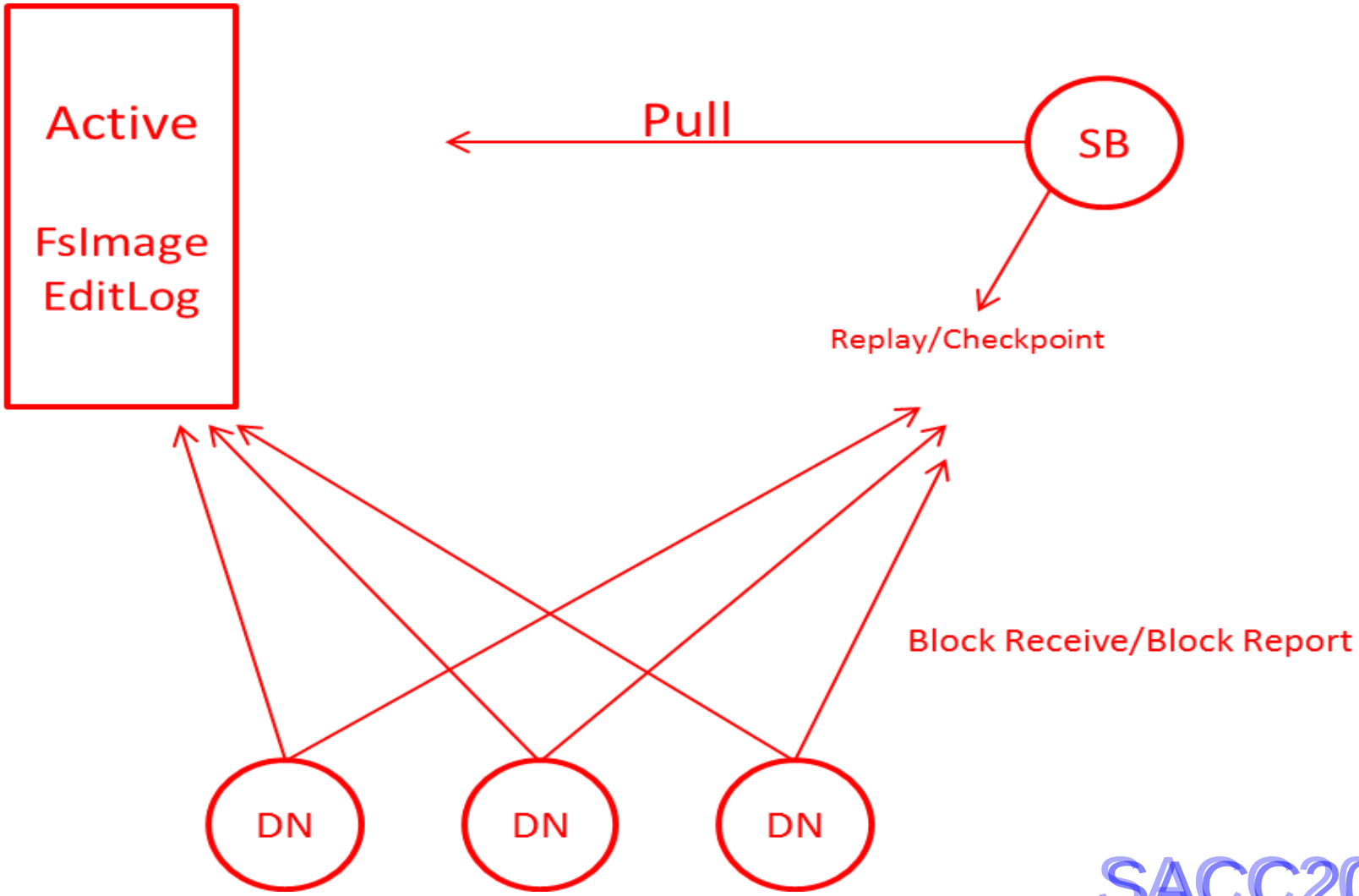


+ #1
- 1.txt - xxx
- 2.txt - xxx
+ #4
- 3.txt - xxx
- 4.txt - xxx

+ #2
- 1.txt - xxx
- 2.txt - xxx

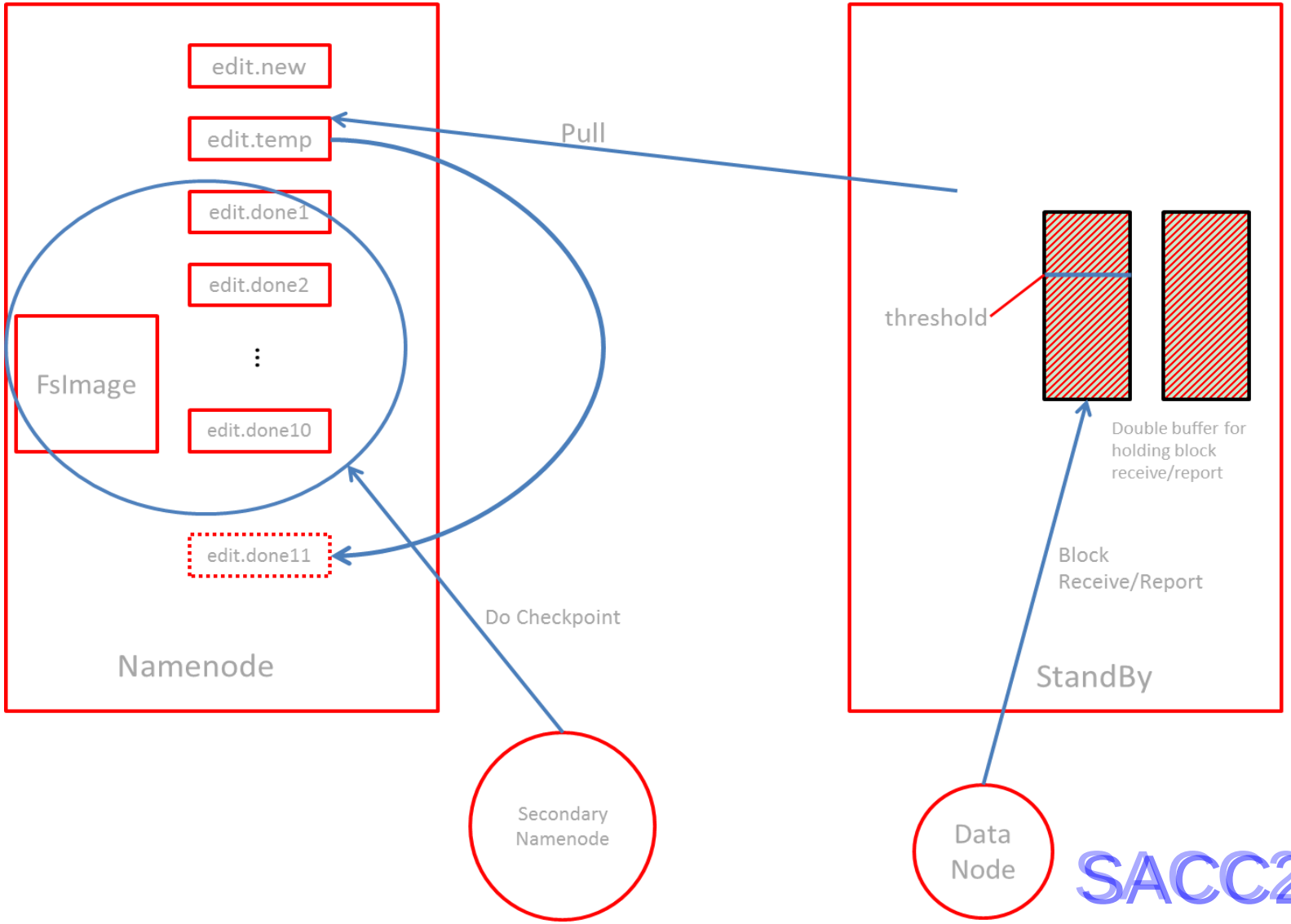
+ #3
- 1.txt - xxx
- 2.txt - xxx

Baidu-HDFS2-Availability

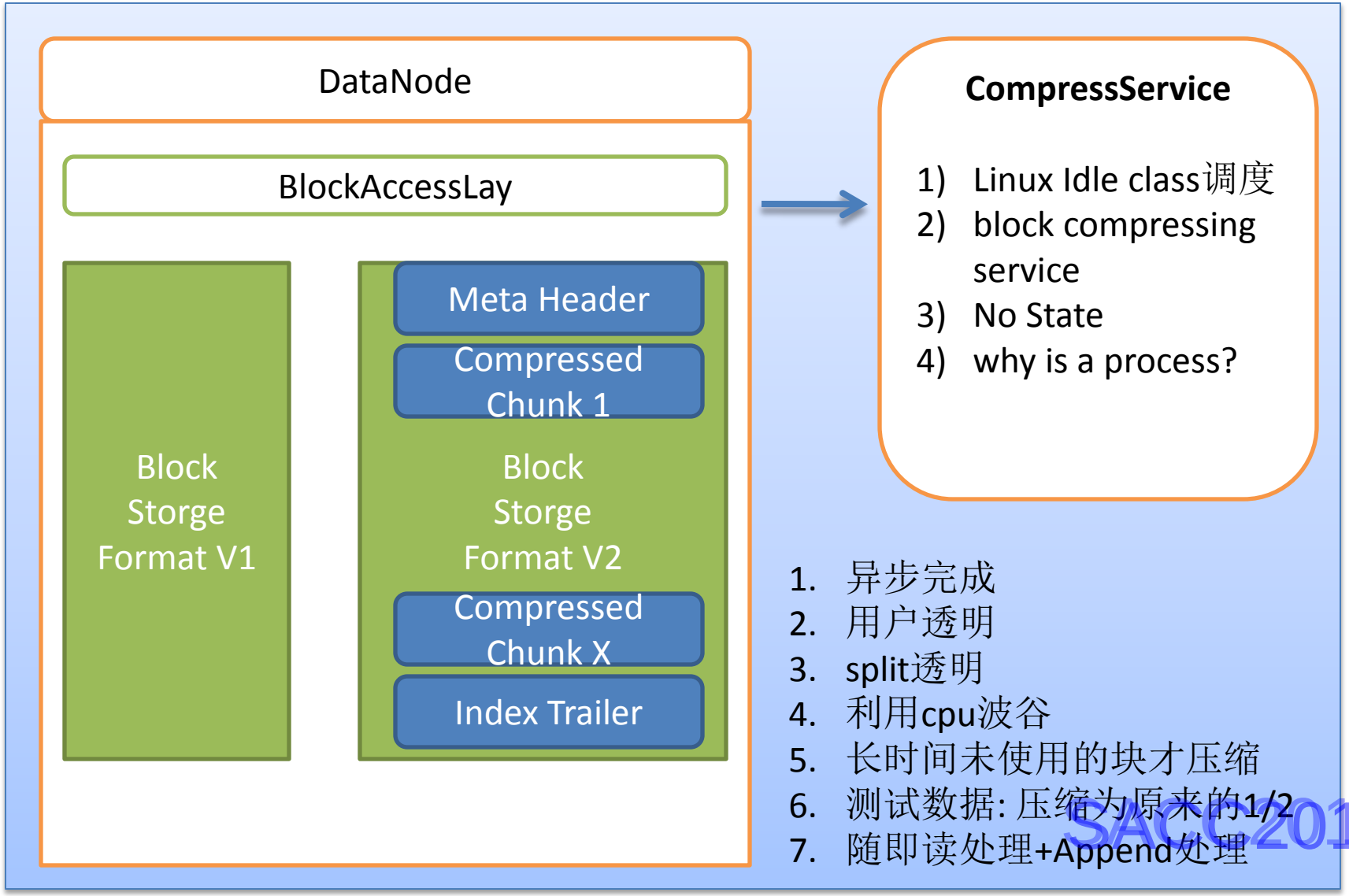


Baidu-hdfs2-availability

1) 允许丢失1分钟的数据
2) 改动简单，对namenode服务影响最小



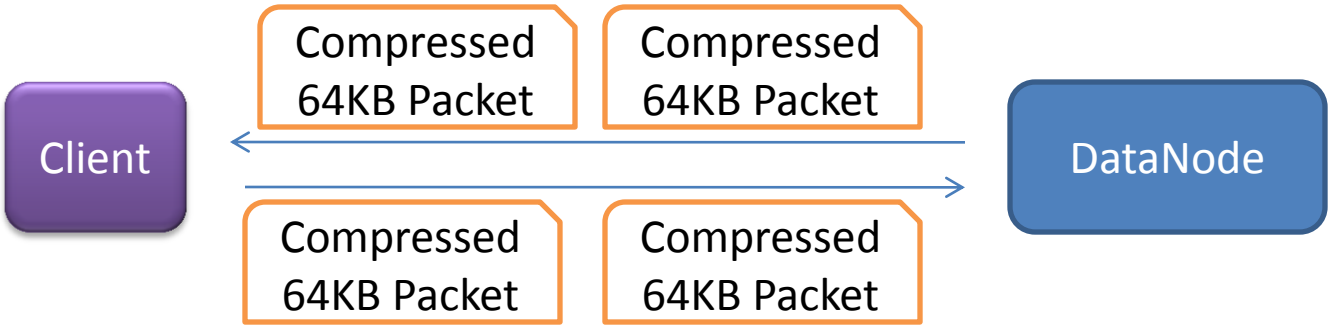
Baidu-HDFS2-透明压缩



Baidu-HDFS2-透明传输

改进前

改进后

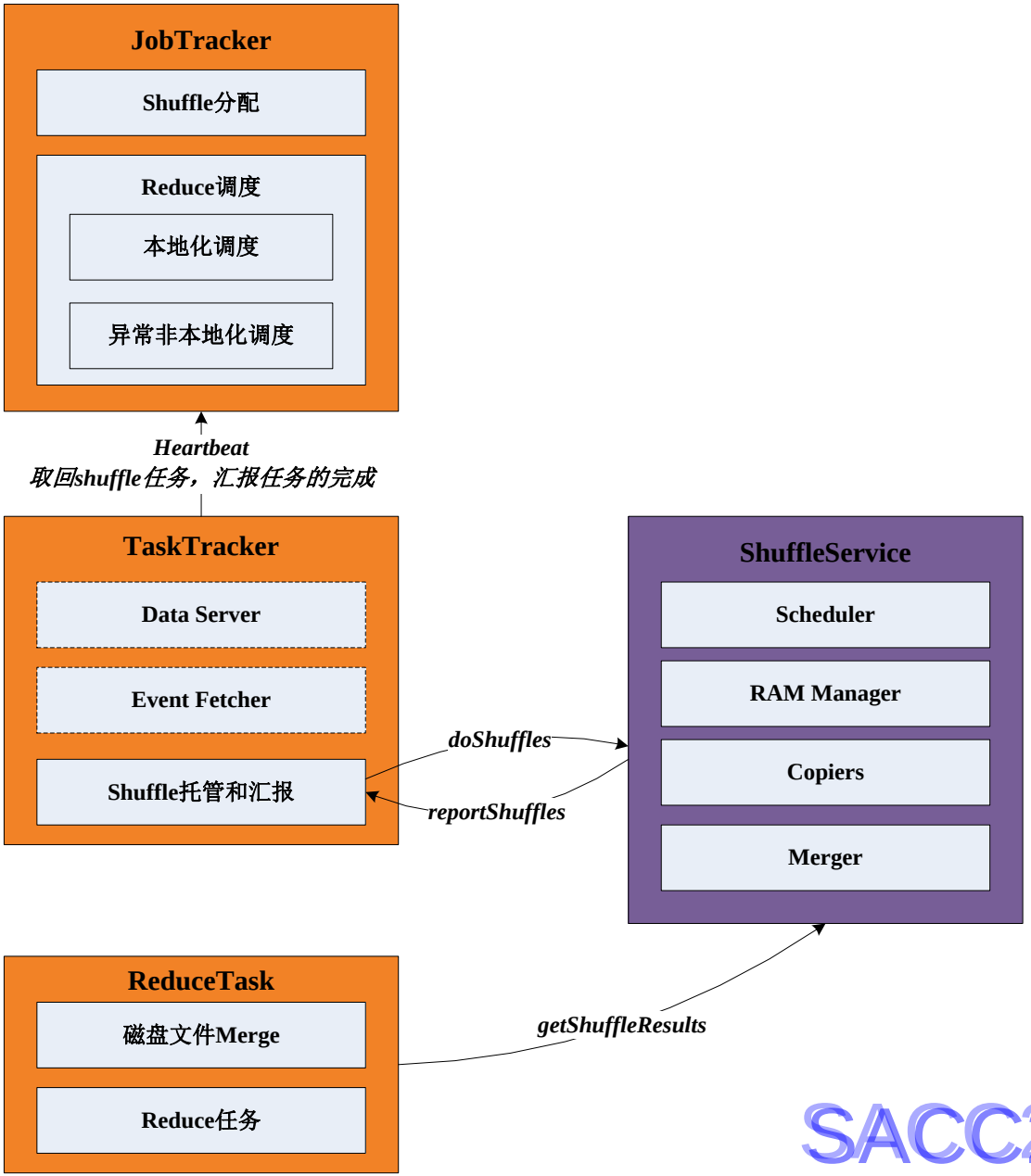


测试数据: 100MB/s -> 175MB/s

Baidu-MR2.0

- Shuffle独立 *
- Map和Reduce Task同治调度
- 资源调度
  - 去除slots，按cpu、mem调度
  - 资源隔离: cgroup、Linux container
- Scalability - Distributed JobTracker *
  - AppTracker + JobTracker
- Availability – JobTracker Failover
  - job recover
  - task recover

Shuffle独立架构



Hadoop job_201108291638_0002 on jx-hadoop-rmaster

User: root
Job Name: streamjob34428.jar
Job Priority: NORMAL
Job Map Capacity: 100
Job Map Over Capacity Allowed: true
Job Reduce Capacity: 100
Job Reduce Over Capacity Allowed: true
Job Queue: defaultqueue
Job Groups: default
Job File: hdfs://jx-hadoop-rmaster.jx:34002/system/mapred/job_201108291638_0002/job.xml
Job Setup: Successful
Status: Running
Started at: Mon Aug 29 16:49:15 CST 2011
Running for: 1mins, 30sec
Job Cleanup: Pending
Job Error: No error
Shuffle and Reduce Cache Info: Shuffle and Reduce-Cache Info

Kind	% Complete	Num Tasks	Pending	Running	Complete	Killed	Failed/Killed Task Attempts
map	63.28%	420	122	70	228	0	0 / 0
reduce	0.00%	200	200	0	0	0	0 / 0

	Counter	Map	Reduce	Total
File Systems	HDFS bytes read	34,356,154,491	0	34,356,154,491
	Local bytes read	7,852,015,752	0	7,852,015,752
	Local bytes written	15,722,691,206	0	15,722,691,206
Job Counters	Rack-local map tasks	0	0	82
	Launched map tasks	0	0	298

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Hadoop job_201108291638_0001 on jx-hadoop-rmaster

User: root
Job Name: streamjob26250.jar
Job Priority: NORMAL
Job Map Capacity: 100
Job Map Over Capacity Allowed: true
Job Reduce Capacity: 100
Job Reduce Over Capacity Allowed: true
Job Queue: defaultqueue
Job Groups: default
Job File: hdfs://jx-hadoop-rmaster.jx:34002/system/mapred/job_201108291638_0001/job.xml
Job Setup: Successful
Status: Running
Started at: Mon Aug 29 16:42:46 CST 2011
Running for: 3mins, 38sec
Job Cleanup: Pending
Job Error: No error
Shuffle and Reduce Cache Info: Shuffle and Reduce-Cache Info

Kind	% Complete	Num Tasks	Pending	Running	Complete	Killed	Failed/Killed Task Attempts
map	100.00%	420	0	0	420	0	0 / 0
reduce	44.25%	200	87	70	43	0	0 / 0

	Counter	Map	Reduce	Total
File Systems	HDFS bytes read	60,026,968,560	0	60,026,968,560
	HDFS bytes written	0	7,499,480,000	7,499,480,000
	Local bytes read	13,429,715,177	1,712,680,519	15,142,395,696
	Local bytes written	27,233,186,398	0	27,233,186,398
Job Counters	Launched reduce tasks	0	0	113
	Rack-local map tasks	0	0	124
	Launched map tasks	0	0	420

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Shuffle Service Admininstration

Ram Manager

shuffleBufferMegabytes	maxSingleShuffleLimit	startMergePercent(%)	PercentUsed(%)	waitForMemoryThreads	numStarted	numClosed	maxInMemOutputs	m
1024	33554432	80.0	0.0	0	0	0	20000	0.

Shuffle Result

ShuffleID	JobPriority	ResultStatus	ResultFileNum	ResultFileList
job_201108291638_0001-195	NORMAL	DONE	2	&file:/home/disk4/dcmmapred/shuffleService/job_201108291638_0001/195/output/map_283.out& /shuffleService/job_201108291638_0001/195/output/map_46.out
job_201108291638_0001-198	NORMAL	DONE	2	&file:/home/disk6/dcmmapred/shuffleService/job_201108291638_0001/198/output/map_351.out& /shuffleService/job_201108291638_0001/198/output/map_2.out
job_201108291638_0001-197	NORMAL	DONE	2	&file:/home/disk7/dcmmapred/shuffleService/job_201108291638_0001/197/output/map_176.out& /shuffleService/job_201108291638_0001/197/output/map_46.out
job_201108291638_0001-199	NORMAL	DONE	2	&file:/home/disk8/dcmmapred/shuffleService/job_201108291638_0001/199/output/map_352.out& /shuffleService/job_201108291638_0001/199/output/map_46.out

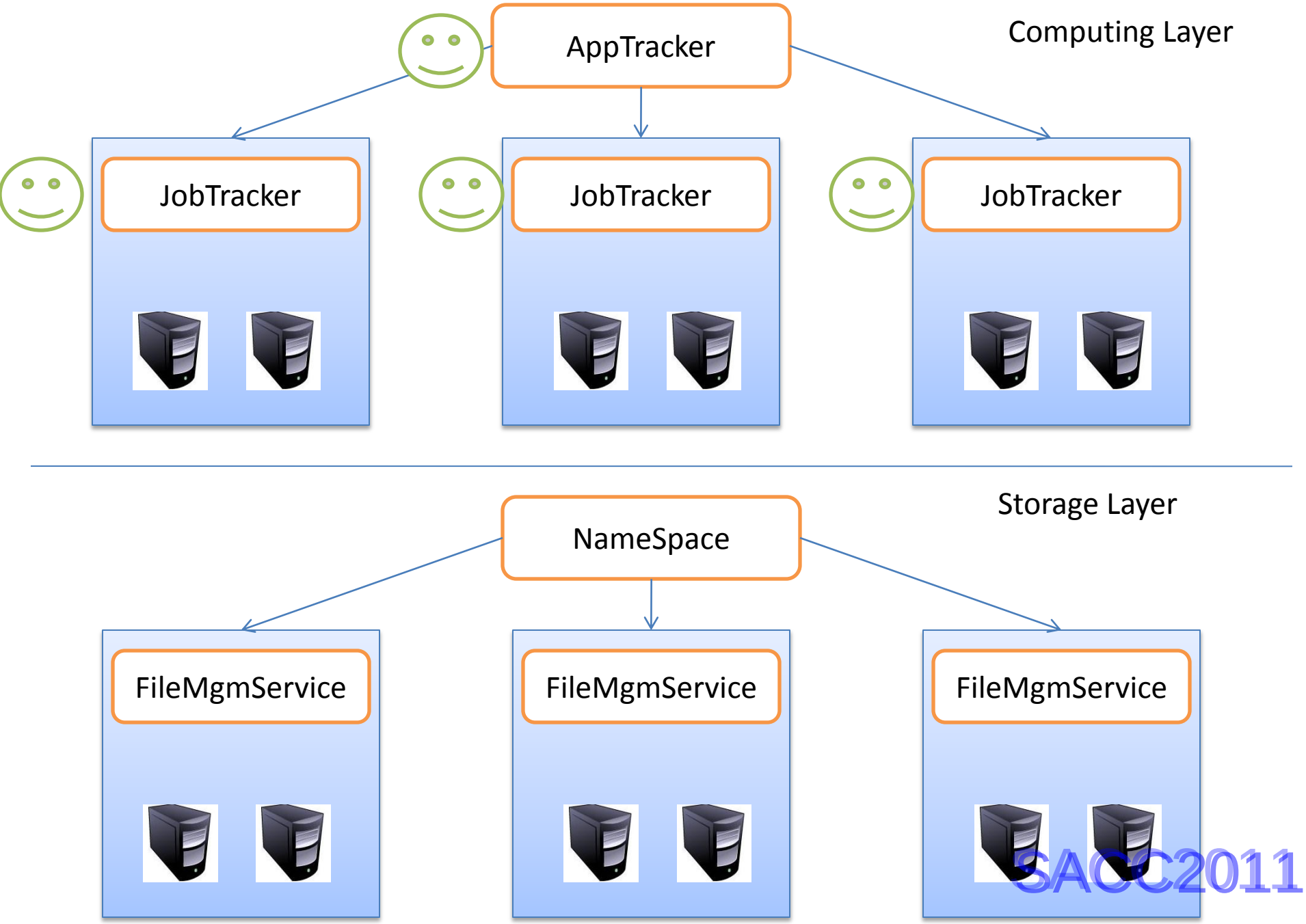
ShuffleWorks

shuffleWork	totalMaps	remainingMaps	usedMem	inMemorySegments	onDiskSegments	totalFailures	pendingHosts	fetchFailedMaps	penalties

ShuffleCopiers

Copier-Id	Running ShuffleWork
1	null
2	null
3	null
4	null
5	null

- Scalability - Distributed JobTracker
  - 一个app有多个job组成
  - jobtracker可以独立运行，apptracker只是更高层的一个应用
  - 实现非常简单
  - 规模可以做到很大
  - 需要底层存储支持
  - 适合未来跨集群完成计算
  - 可以融合进Community-MapReduce2.0


Computing Layer
AppTracker
JobTracker
JobTracker
JobTracker
Storage Layer
NameSpace
FileMgmService
FileMgmService
FileMgmService
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TODO- CloudTransfer

- 流式传输
  - flume, scribe
- 批量传输
  - 节点间数据移动
  - 一到一
  - 一到多（树状分发，解决类似jar包分发，cachearchive问题）
  - 节点到hdfs, hdfs到节点
  - hdfs到hdfs
  - 第3方控制

Master

task-1： A:/1 -> B:/1

task-2： C:/2 -> B:/2, D:/3, E:/4

task-3： F:/5 -> indexserver-*/5

- 优先级控制
- 带宽控制
- 动态调整
- 出错控制
- stop/resume
- 广域网优化
- … …

- compress
- small file 优化
- 带宽控制

TODO-MR-Ontime

- throughput
  - 时效性不保证(> 2小时)
  - 追求: 吞吐最高(资源利用率)
- realtime
  - 时效性最高(< 10分钟时效性要求)
  - 追求: 完成latency
  - Twitter-Storm/Linkedin-Kafka
- ontime
  - 时效性中等(10分钟 – 2小时)
  - 追求: 就如同地铁，也许速度不快，但是预期稳定
- 追求不同，侧重点就要不同

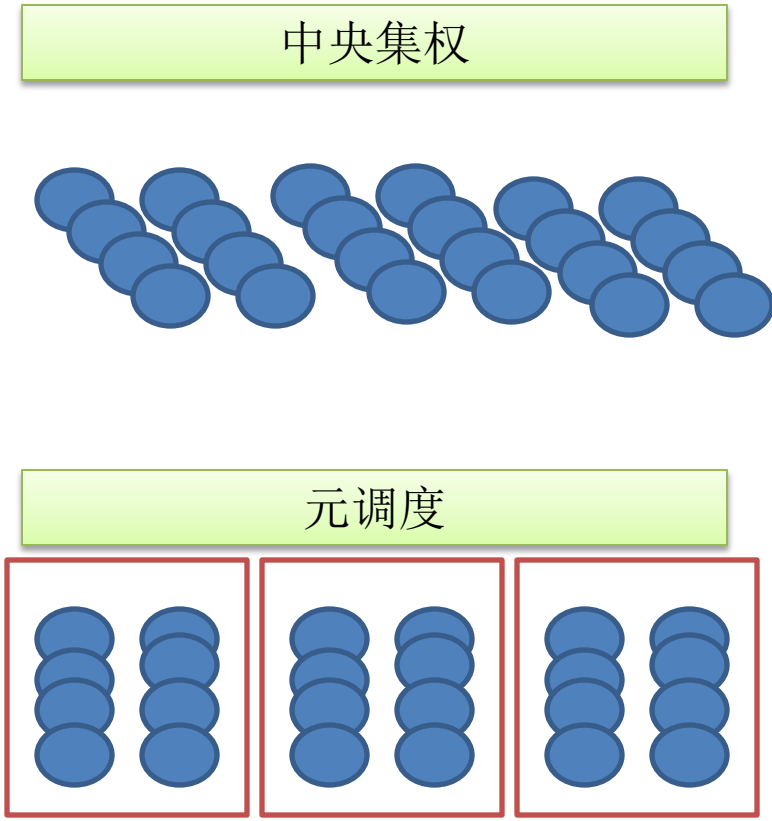
computing-realtime

computing-ontime

computing-throughput

TODO-Big,Big,Big Cluster?

- Datacenter
  - 1w
- 系统复杂度提高
- 问题影响面太大
- 系统升级也是个大麻烦
- 解决思路:
  - “中央集权”走向“地方分权”
  - storage.com, computing.com



Q & A

THANKS