# MongoDB & Spark

Meteor.js Startup(구 WeBooster) 대표/개발팀장
진정원

# 소개

- 한국정보통신 SW 연구소
- KTds SW 연구소
- Meteor.js Startup
  - 오픈소스 활성화
  - 정부과제
  - Startup 컨설팅 / 개발지원
  - 카톨릭 대학교 MOU
- meteorstartup@gmail.com

- 카톨릭대학교 - Javascript & 오픈소스
- 한국인터넷진흥원 - HTML5 / Javascript / CSS 중/고급 코스
- Meteor Startup - Meteor.js, MongoDB 초/중급 코스
- LS산전 - 빅데이터의 이해, 데이터 마이닝과 분석
- Micro Software - 웹앱을 만드는 보다 나은 방법, Meteor.js
- 미림 마에스터 고등학교 - 리눅스/네트워크 이해

# MongoDB

# DB Rank

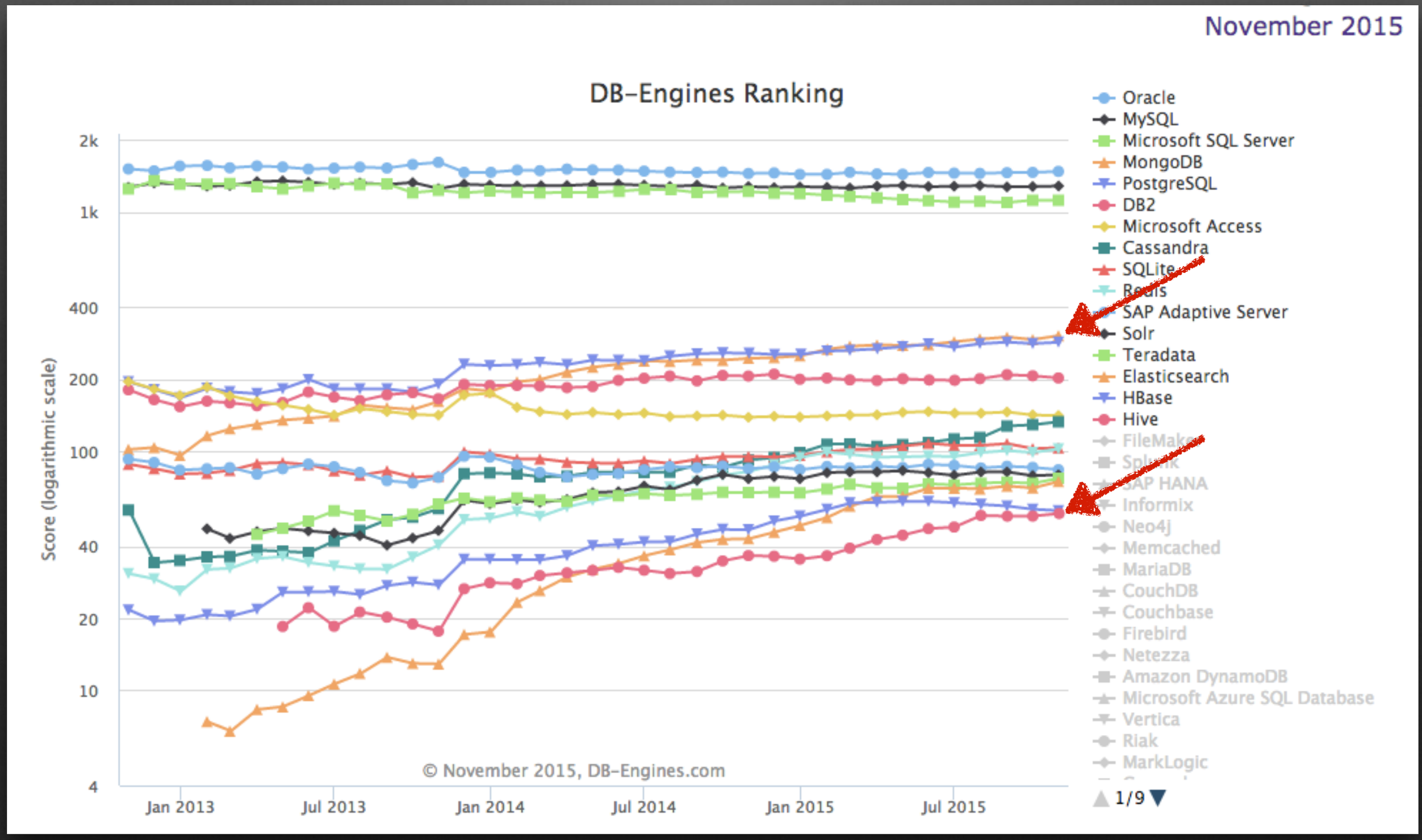
283 systems in ranking, November 2015

| Rank Nov 2015 | Rank Oct 2015 | Rank Nov 2014 | DBMS | Database Model | Score Nov 2015 | Score Oct 2015 | Score Nov 2014 |
|---|---|---|---|---|---|---|---|
| 1. | 1. | 1. | Oracle | Relational DBMS | 1480.95 | +13.99 | +28.82 |
| 2. | 2. | 2. | MySQL | Relational DBMS | 1286.84 | +7.88 | +7.77 |
| 3. | 3. | 3. | Microsoft SQL Server | Relational DBMS | 1122.33 | -0.90 | -97.87 |
| 4. | 4. | ↑ 5. | MongoDB ⊞ | Document store | 304.61 | +11.34 | +59.87 |
| 5. | 5. | ↓ 4. | PostgreSQL | Relational DBMS | 285.69 | +3.56 | +28.33 |
| 6. | 6. | 6. | DB2 | Relational DBMS | 202.52 | -4.28 | -3.71 |
| 7. | 7. | 7. | Microsoft Access | Relational DBMS | 140.96 | -0.87 | +2.12 |
| 8. | 8. | ↑ 9. | Cassandra ⊞ | Wide column store | 132.92 | +3.91 | +40.93 |
| 9. | 9. | ↓ 8. | SQLite | Relational DBMS | 103.45 | +0.78 | +8.17 |
| 10. | 10. | ↑ 11. | Redis ⊞ | Key-value store | 102.41 | +3.61 | +20.06 |
| 11. | 11. | ↓ 10. | SAP Adaptive Server | Relational DBMS | 83.71 | -1.93 | -0.91 |
| 12. | 12. | 12. | Solr | Search engine | 79.77 | +0.71 | +2.96 |
| 13. | 13. | 13. | Teradata | Relational DBMS | 77.08 | +3.64 | +9.85 |
| 14. | 14. | ↑ 16. | Elasticsearch | Search engine | 74.77 | +4.55 | +31.71 |
| 15. | 15. | 15. | HBase | Wide column store | 56.46 | -0.78 | +9.49 |
| 16. | 16. | ↑ 17. | Hive | Relational DBMS | 54.91 | +1.35 | +18.30 |
| 17. | 17. | ↓ 14. | FileMaker | Relational DBMS | [illegible] | [illegible] | [illegible]9 |
| 18. | 18. | ↑ 20. | Splunk | Search engine | 44.61 | +1.11 | +12.44 |

I love Hadoop!

http://db-engines.com/en/ranking

# DB Rank




http://db-engines.com/en/ranking

# MongoDB 활용기업

AstraZeneca
BOSCH
Google
verizon
CISCO
ebay
VIACOM
facebook
MTV
CHICO'S
MetLife
SAP
Adobe
Medtronic
BuzzFeed
bouygues
GAP
The New York Times
Telefónica
360
Genentech
NBCUniversal
NOKIA
craigslist
Expedia
APOLLO GROUP
eHarmony
ADP
hudl
CARFAX
BROAD INSTITUTE

# Wordnik

- 온라인 Dictionary 사이트
- 3~5TB MySQL to MongoDB 전환
- x20 성능향상

# Shutterfly

- 사진 정보 관리 사이트
- SUN Server/JAVA/20TB Oracle DB to MongoDB 전환
- 500% 비용절감
- 900% 성능 향상

# Disney

- Disney Interactive Media Group
- Game, Media Content 정보 관리
- MySQL to MongoDB 전환
- Replica Set & Auto Sharding 분산 환경 적용

# Forbes

- Business Media Brand
- Oracle to MongoDB 전환
- 전사적으로 전체 데이터에 대해서 확대 적용 중

# 오라클 정조준한 오픈소스SW 성과공유 사업 모델 선봬

KT그룹 계열사인 KT DS가 오라클 소프트웨어(SW)를 타깃으로 오픈소스 성과 공유형 사업 모델을 선보였다. 유지보수 비용이 높은 오라클 등 외산 SW를 오픈소스SW로 무상 교체해준 후 절감된 비용을 공유하는 사업 구조다. 외산 SW 높은 유지보수 비용에 부담을 느끼는 상당수 기관·기업이 관심을 가질 전망이다.

KT DS는 15일 기자간담회를 갖고 국내 오픈소스SW 시장 활성화와 기업 IT비용 절감을 위해 '오픈소스 성과 공유형 사업모델'을 추진한다고 밝혔다. 오픈소스SW 교체 대상은 운용체계(OS), 데이터베이스관리시스템(DBMS), 웹애플리케이션서버(WAS), 웹서버 등 상용SW다.

KT DS가 중점을 두는 영역은 오라클 DBMS다. 오라클 DBMS 제품은 22%의 높은 유지보수 요율을 요구한다. 최근 오라클 DBMS 도입 기관·기업과 유지보수 요율을 놓고 갈등을 겪었다.

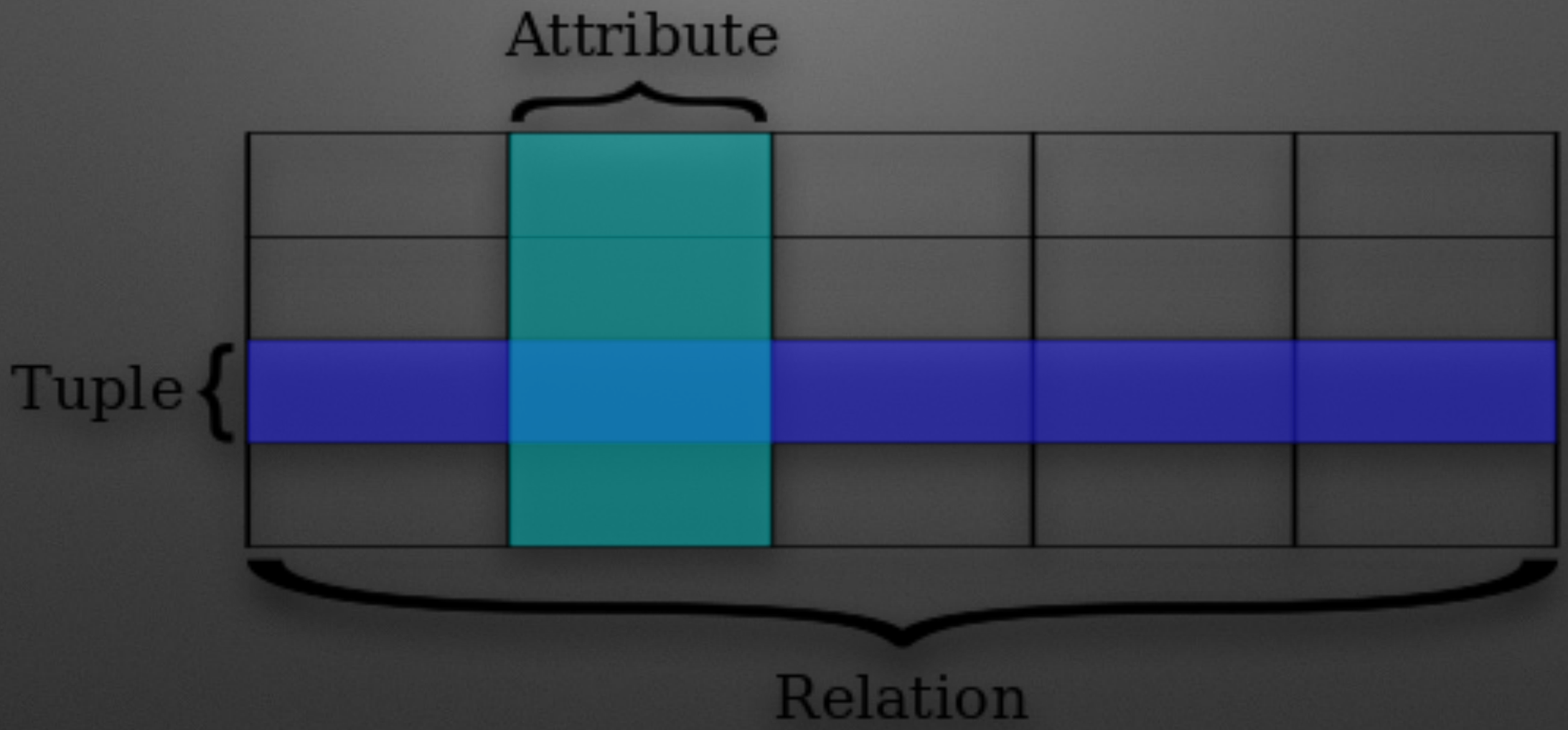
손승혜 KT DS IT서비스혁신센터장은 "아직까지 상당수 기관과 기업이 핵심 영역은 물론이고 비핵심 영역에서도 유지보수 요율이 높은 외산 DBMS에 의존한다"며 "오픈소스SW로 대체하면 비용절감 효과가 크다"고 설명했다.

KT는 신인증시스템 등 주요 30개 정보시스템 DBMS를 오라클 제품 대신 오픈소스인 엔터프라이즈DB(EDB) 포스트그레스 플러스 어드밴스트 서버로 교체했다. 5년간 2000억원 비용절감 효과를 기대한다.

# Campung

- 취업 정보 제공 모바일 앱
- JAVA(Spring) + MySQL to Meteor.js + MongoDB
- 월 평균 3000만건의 사용자 로그 데이터 분석
- 어마어마한 성능 향상

# RDBMS



# RDBMS 빅데이터 대응

- 반정규화 (Denormalization)
- Stored Procedure 사용금지
- 데이터베이스 기능의 사용범위 제한
- 빈번한 쿼리를 미리 만들어 대응
- 보조 색인 사용 금지
- PK 키 외 사용 금지
- 샤딩 (수평적 파티션에 레코드를 논리적으로 분할)

# RDBMS 빅데이터 대응

- Replication
  - 복제에 의한 확장
  - Master - Slave 구조
- Partitioning (Sharding)
  - 분할에 의한 확장
  - Join 불가능

# 비(반)정형 데이터

```
{
    key: ‘value’,
    obj: {
        key: ‘value’
    },
    arr: [
        ‘val1’,
        ‘val2’
    ]
}
```

```
<xml>
    <some>
        <data>
            value
        </data>
        <array>
            <item>
                value
            </item>
        </array>
    </some>
</xml>
```

# NoSQL DB

| KVS | Ordered KVS | Column | Document | Graph |
|---|---|---|---|---|
| In-Memory | Tokyotyrant | Simple DB | CouchDB | Neo4j |
| Memcached | Lightcloud | BigTable | MongoDB | FlockDB |
| Infinispan | NMDB | Hbase | Lotus Domino | InfiniteGraph |
| Oracle Coherence | Luxio | Cassandra | Riak | |
| Disk Based | Memcachedb | HyperTable | ThruDB | |
| Redis | | Azure TS | | |
| Dynamo | | | | |
| Voldemort | | | | |

# MongoDB

- 10gen(MongoDB로 사명 변경)에서 만든 Document 기반의 NoSQL 스토리지
- Document-Oriented Storage : 모든 데이터가 JSON 형태로 저장되며 schema 없음
- Full Index Support : RDBMS에 뒤지지 않는 다양한 인덱싱 제공
- Replication & High Availability : 데이터 복제를 통해 가용성을 향상
- Auto-Sharding : Primary key를 기반으로 여러 서버에 데이터를 나누는 scale-out 가능

# MongoDB

- Querying : key 기반의 get, put 뿐만이 아니라 다양한 종류의 쿼리들을 제공
- Fast In-Place Updates : 고성능의 atomic operation을 지원
- Map/Reduce : 맵리듀스를 지원
- Aggregation: MongoDB 2.2부터 지원
- GridFS : 별도 스토리지 엔진을 통해 파일을 저장
- BSON: Document(json)의 직렬 바이너리 포맷

# Insert

```
db.inventory.insert(
   {
     item: "ABC1",
     details: {
        model: "14Q3",
        manufacturer: "XYZ Company"
     },
     stock: [ { size: "S", qty: 25 }, { size: "M", qty: 50 } ],
     category: "clothing"
   }
)
```

# Operators

- 비교 연산자
  - $cmp / $eq / $gt / $gte / $lt / $lte / $ne
- Boolean 연산자
  - $and / $not / $or

# Operators

- 산술 연산자
  - $add / $devide / $mod / $multiply / $subtract / $inc
- 문자 연산자
  - $strcasecmp / $substr / $toUpper / $toLower
- 정규표현식
  - db.employees.find({name: {$regex: ‘kim*’, $options: ‘m’}}, {empno:”, ename:”});

# Find

```
db.inventory.find( {} )
db.inventory.find( { type: "snacks" } )
db.inventory.find( { type: { $in: [ 'food', 'snacks' ] } } )
db.inventory.find( { type: 'food', price: { $lt: 9.95 } } )
db.inventory.find(
   {
     $or: [ { qty: { $gt: 100 } }, { price: { $lt: 9.95 } } ]
   }
)
db.inventory.find( { type: 'food' }, { item: 1, qty: 1 } )
db.inventory.find( { type: 'food' }, { item: 1, qty: 1, _id:0 } )
```

# _id

- ObjectId is a 12-byte BSON type, constructed using:
  - a 4-byte value representing the seconds since the Unix epoch,
  - a 3-byte machine identifier,
  - a 2-byte process id, and
  - a 3-byte counter, starting with a random value.
- ObjectId(“507f191e810c19729de860ea").getTimestamp()
  - ISODate(“2012-10-17T20:46:22Z”)
- ObjectId("507f191e810c19729de860ea").str

# Cursor

```
var myCursor = db.inventory.find( { type: 'food' } );
while (myCursor.hasNext()) {
   print(tojson(myCursor.next()));
}

var myCursor =  db.inventory.find( { type: 'food' } );
myCursor.forEach(printjson);
```

# Explain

- db.collection.explain(“options”)
- db.collection.find().explain(“options”)
- options
  - queryPlanner
  - executionStats
  - allPlansExecution

# Update

```
db.inventory.update(
    { item: "MNO2" },
    {
      $set: {
        category: "apparel",
        details: { model: "14Q3", manufacturer: "XYZ Company" }
      },
      $currentDate: { lastModified: true }
    },
    { multi: true }
)
```

# Upsert

```
db.inventory.update(
   { item: "TBD1" },
   {
     item: "TBD1",
     details: { "model" : "14Q4", "manufacturer" : "ABC Company" },
     stock: [ { "size" : "S", "qty" : 25 } ],
     category: "houseware"
   },
   { upsert: true }
)
```

# Save

```
db.products.save( { item: "book", qty: 40 } )
db.products.save( { _id: 100, item: "water", qty: 30 } )
db.products.save(
    { item: "envelopes", qty : 100, type: "Clasp" },
    { writeConcern: { w: "majority", wtimeout: 5000 } }
)
```

# WriteConcern

- { w: <value>, wtimeout: <number> }
- w options
  - 1(default): Requests acknowledgement that the write operation has propagated to the standalone mongod or the primary in a replica set.
  - 0: Requests no acknowledgment of the write operation.
  - “majority”: Requests acknowledgment that write operations have propagated to the majority of voting nodes [1], including the primary, and have been written to the on-disk journal for these nodes.

# Remove

```
db.inventory.remove({})
db.inventory.remove( { type : "food" } )

db.inventory.remove( { type : "food" }, 1 )
db.inventory.remove( { type : "food" }, true )
```

# Index

- Index명 대소문자 구분
- Sort()와 Limit()을 통한 성능 향상

- db.collection.ensureIndex();
- db.collection.reIndex();
- db.collection.dropIndexes();

# Index

- Non Unique Index: Field의 중복값 허용
  - Single Key Index: {empno: -1}
  - Compound Key Index: {empno: -1, empname: 1}
- Unique Index: Field의 유일값. {unique: true}
- Sparse Index: 출현 빈도가 낮은 Field. {sparse: true}
- Background Index: {background: true}
  - 시스템 자원의 부족 / 대용량 데이터의 경우 Seamless 한 Index 생성 가능

# GeoSpatial Index

- 좌표에 의한 2차원 구조의 Collection에 2D Index를 생성
  - {pos: '2d'}
- 다양한 연산자 제공
  - $near / $center / $box / $polygon / $centerSphere / $nearSphere

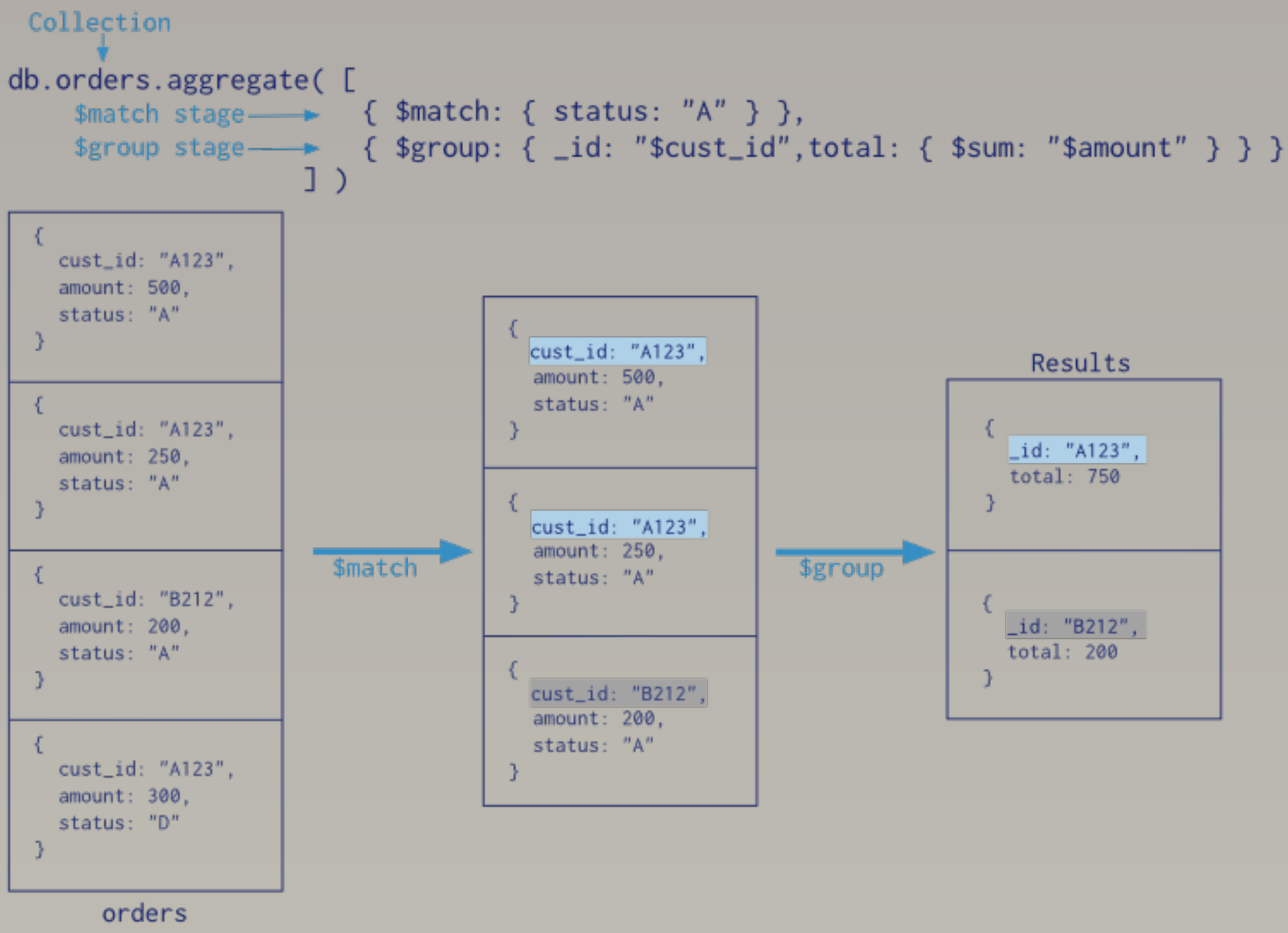
# GeoSpatial Index

- $near: 가장 가까운 좌표
- $center: 가장 가까운 원형 좌표
- $box: 가장 가까운 사각형 좌표
- $polygon: 가장 가까운 다면형 좌표
- $centerSphere: 원형내 좌표 검색
- $nearSphere: 원형외 좌표 검색

# Aggregation

- 순차적으로 데이터를 실시간으로 추출 및 가공
- Sharding Supported
- MapReduce와 비슷한 동작을 수행하지만 빠른 성능 보장
  - 쉽다!!
  - 빠르다!! Use Memory!!
  - 최적화된 연산자 제공
    - $project, $match, $group, $sort, $limit, $skip
- Runs inside MongoDB local data

# Aggregation




https://docs.mongodb.org/manual/aggregation/#aggregation-pipeline

# SQL VS Aggregation

| SQL | AGGREGATION |
| --- | --- |
| SELECT COUNT(*) AS count<br>FROM order | db.order.aggregate([{<br>$group: {_id: null, count: {$sum: 1}}<br>}]) |
| SELECT cust_id, SUM(price) AS total_price<br>FROM order<br>GROUP BY cust_id<br>ORDER BY total_price | db.order.aggregate([<br>{$group: {_id: "$cust_id", total_price: {$sum: "$price"}}},<br>{$sort: {total_price: 1}}<br>]) |
| SELECT cust_id, count(*)<br>FROM order<br>GROUP BY cust_id<br>HAVING count(*) > 1 | db.order.aggregate([<br>{$group: {_id: "$cust_id", count: {$sum: 1}}},<br>{$match: {count: {$gt: 1}}}<br>]) |

# to Dynamic Queries

```
db.logs.find({‘path’: ‘/index.html’})

db.logs.find({‘time’: {
  ‘time’: {‘$gte’: new Date(2013, 0), ‘$lt’: new Date(2013, 0)}
})

db.logs.find({
  ‘host’: ‘127.0.0.1’,
  ‘time’: {‘$gte’: new Date(2013, 0), ‘$lt’: new Date(2013, 1)}
})
```

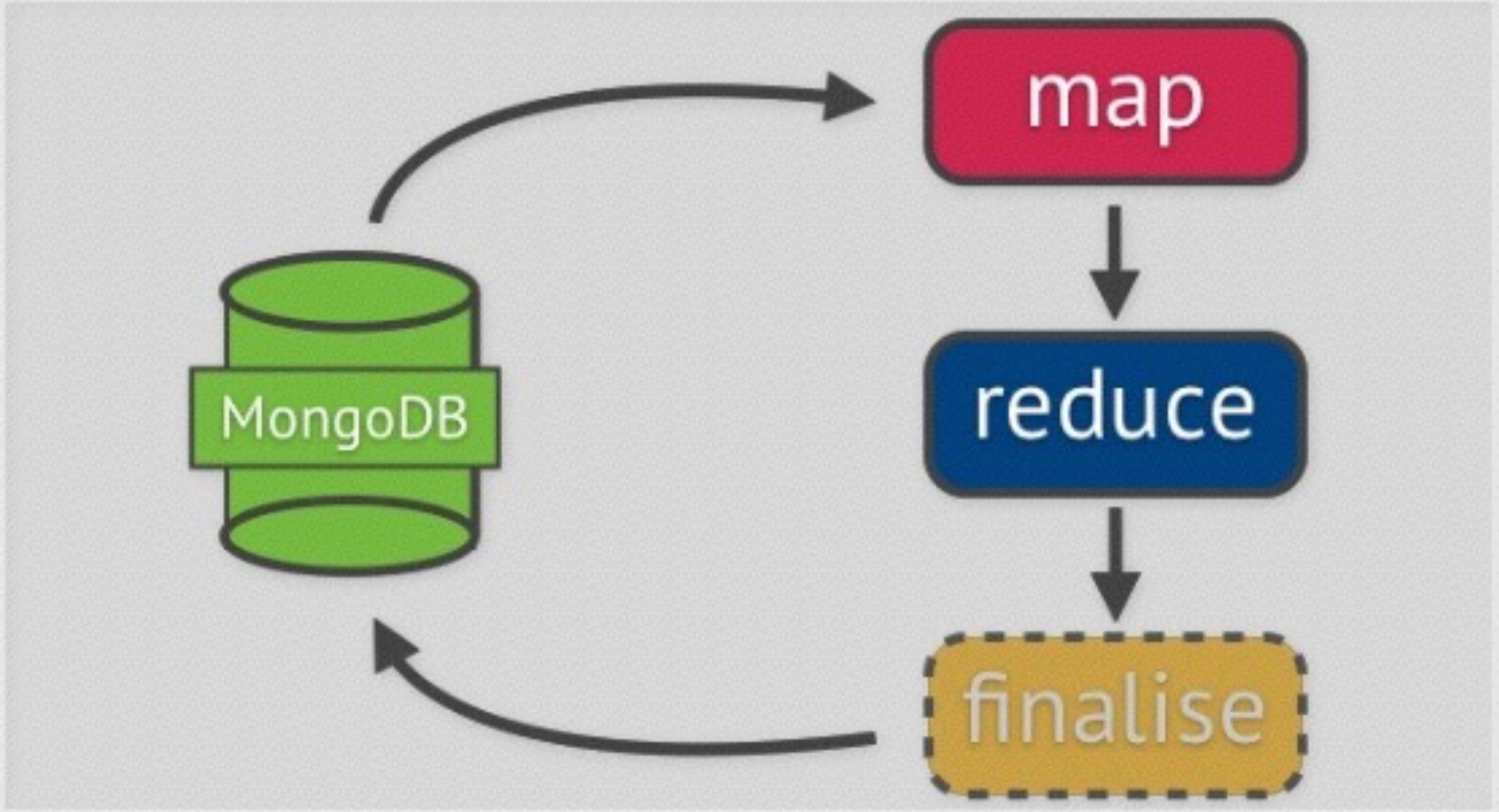
# to Aggregation

```
db.logs.aggregate([
        {'$match': {
                'time': {'$gte': new Date(2013, 0), '$lt': new Date(2013, 1)}}},
        {'$project': {
                'path': 1,
                'date': {
                        'y': {'$year': '$time'},
                        'm': {'$month': '$time'},
                        'd': {'$dayOfMonth': '$time'}}},
        {'$group': {
                '_id': {
                        'p': '$path',
                        'y': '$date.y',
                        'm': '$date.m',
                        'd': '$date.d'},
                        'hits': {'$sum': 1}}}
])
```

# Result


```
{
    'ok': 1,
    'result': [
        {'_id': {'p': '/index.html', 'y': 2013, 'm': 1, 'd': 1}, 'hits': 123},
        {'_id': {'p': '/index.html', 'y': 2013, 'm': 1, 'd': 2}, 'hits': 205},
        {'_id': {'p': '/index.html', 'y': 2013, 'm': 1, 'd': 3}, 'hits': 332},
        {'_id': {'p': '/index.html', 'y': 2013, 'm': 1, 'd': 4}, 'hits': 173},
        {'_id': {'p': '/index.html', 'y': 2013, 'm': 1, 'd': 4}, 'hits': 32},
    ]
}
```

# Map/Reduce




MongoDB Map/Reduce

mongoDB

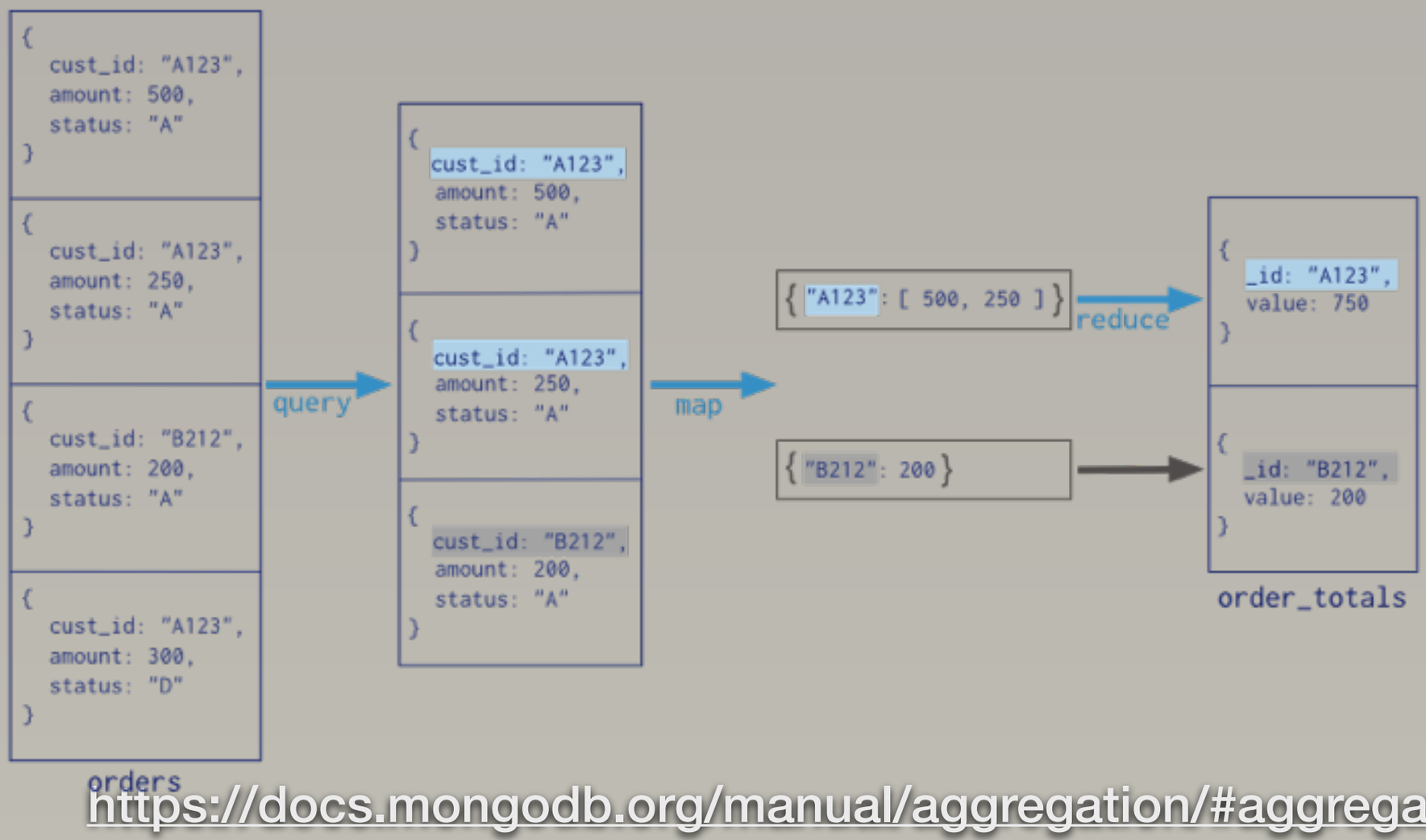
# Map/Reduce

- Hadoop의 Map/Reduce와 유사
- JavaScript
  - pros: 기능성, 표현력 증대. 하둡(JAVA)에 비해 쉽다.
  - cons: Aggregation에 비해 성능 저하
- Runs inside MongoDB local data

# Map/Reduce

Collection

```
db.orders.mapReduce(
          map      ──►  function() { emit( this.cust_id, this.amount ); },
          reduce   ──►  function(key, values) { return Array.sum( values ) },
                        {
          query    ──►    query: { status: "A" },
          output   ──►    out: "order_totals"
                        }
                      )
```




https://docs.mongodb.org/manual/aggregation/#aggregation-pipeline

# Map/Reduce

```
var map = function() {
    var key = {
        p: this.path,
        d: new Date(
            this.ts.getFullYear(),
            this.ts.getMonth(),
            this.ts.getData(),
            this.ts.getHours(),
            0,0,0)};
    emit(key, {hits: 1});
};
```

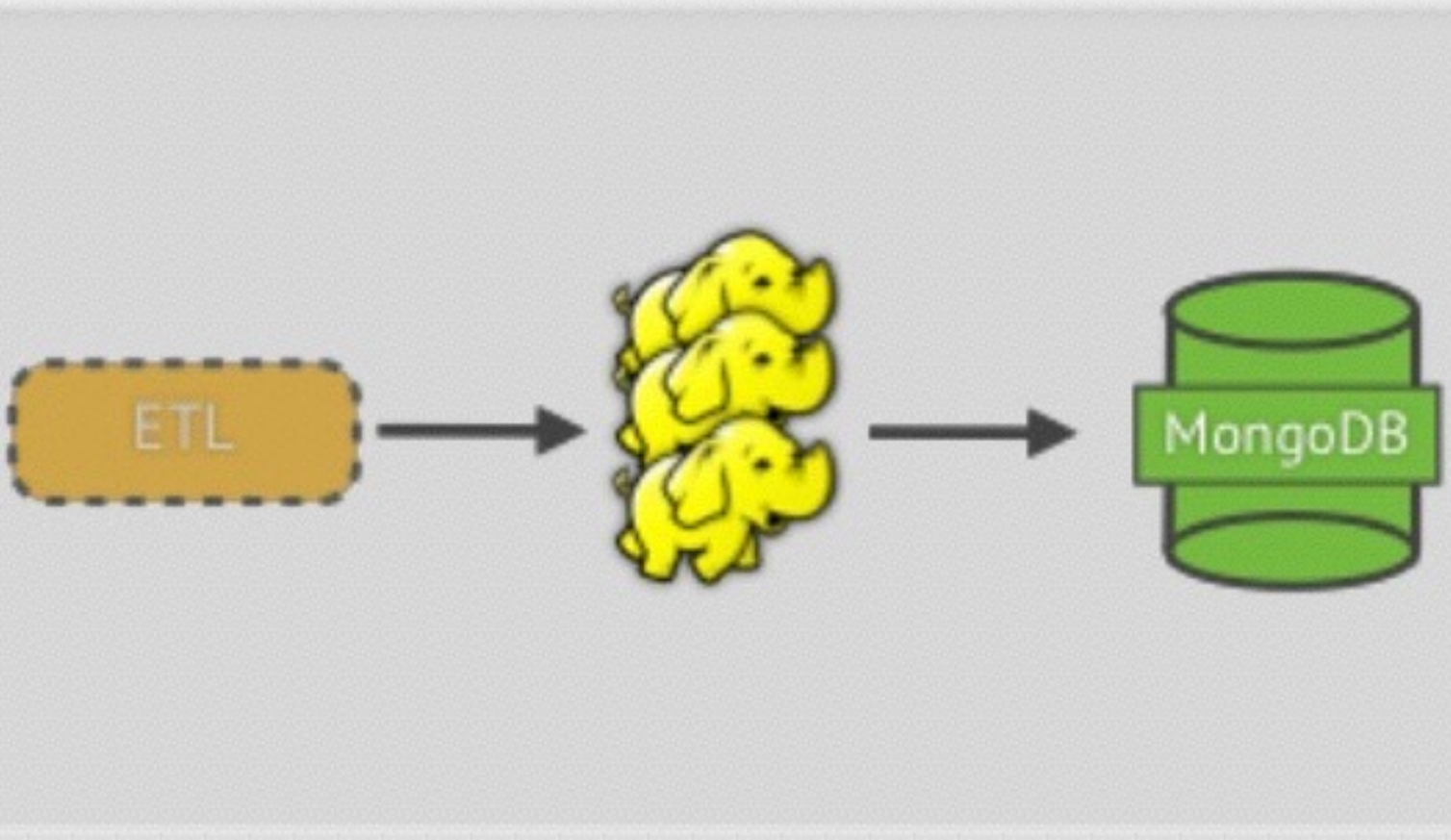
# Map/Reduce

```
var reduce = function(key, values) {
    var r = {hits: 0};
    values.forEach(function(v) {
        r.hits += v.hits;
    });
    return r;
};
```

# Map/Reduce

```
var query = {
    'ts': {
        '$gte': new Date(2013, 0, 1),
        '$lte': new Date(2013, 0, 31)}};

db.logs.mapReduce(map, reduce, {
    'query': query,
    'out': {
        'reduce': 'stats.monthly'}
});
```

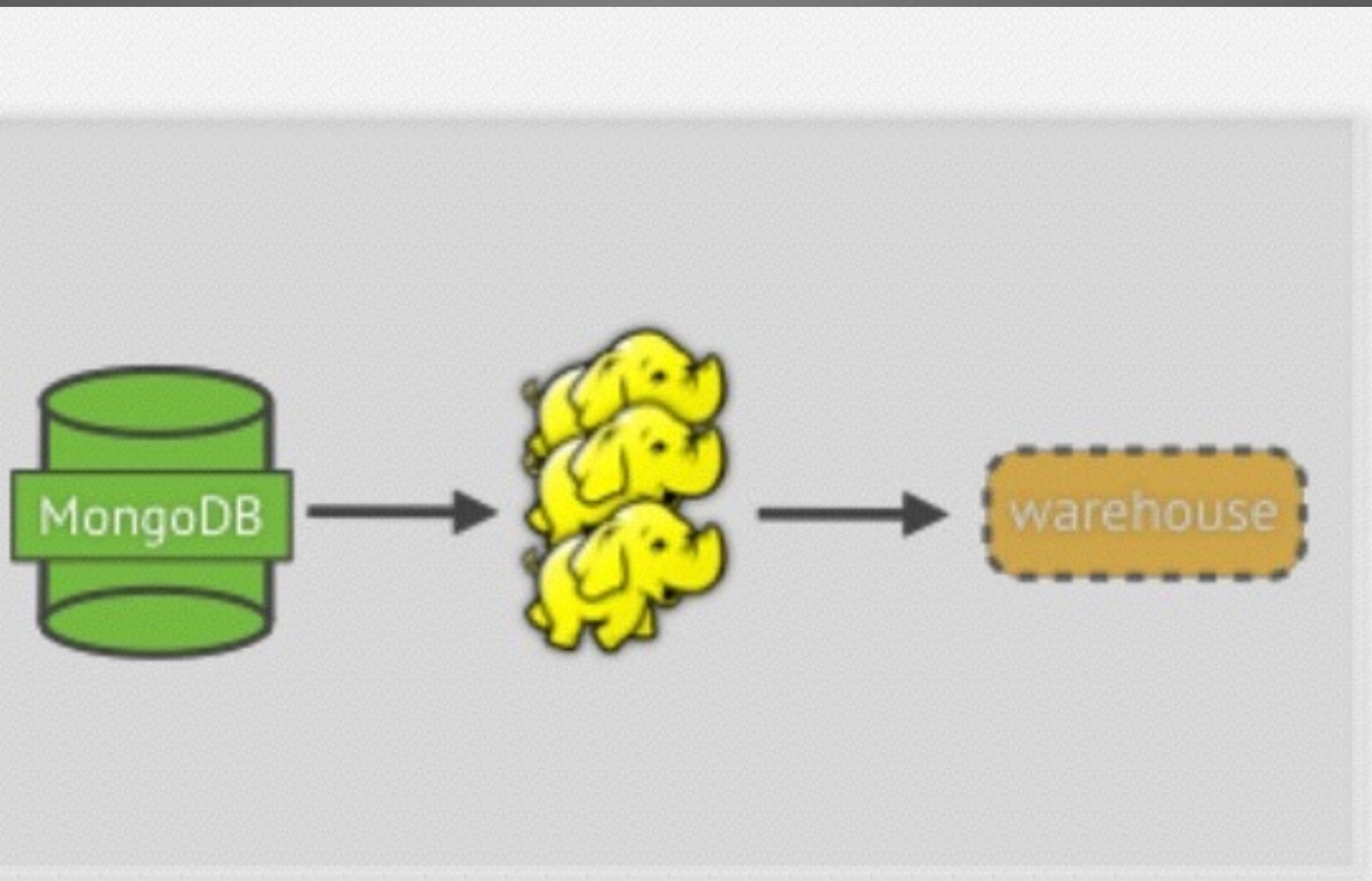
# Hadoop Connector




MongoDB with Hadoop

mongoDB

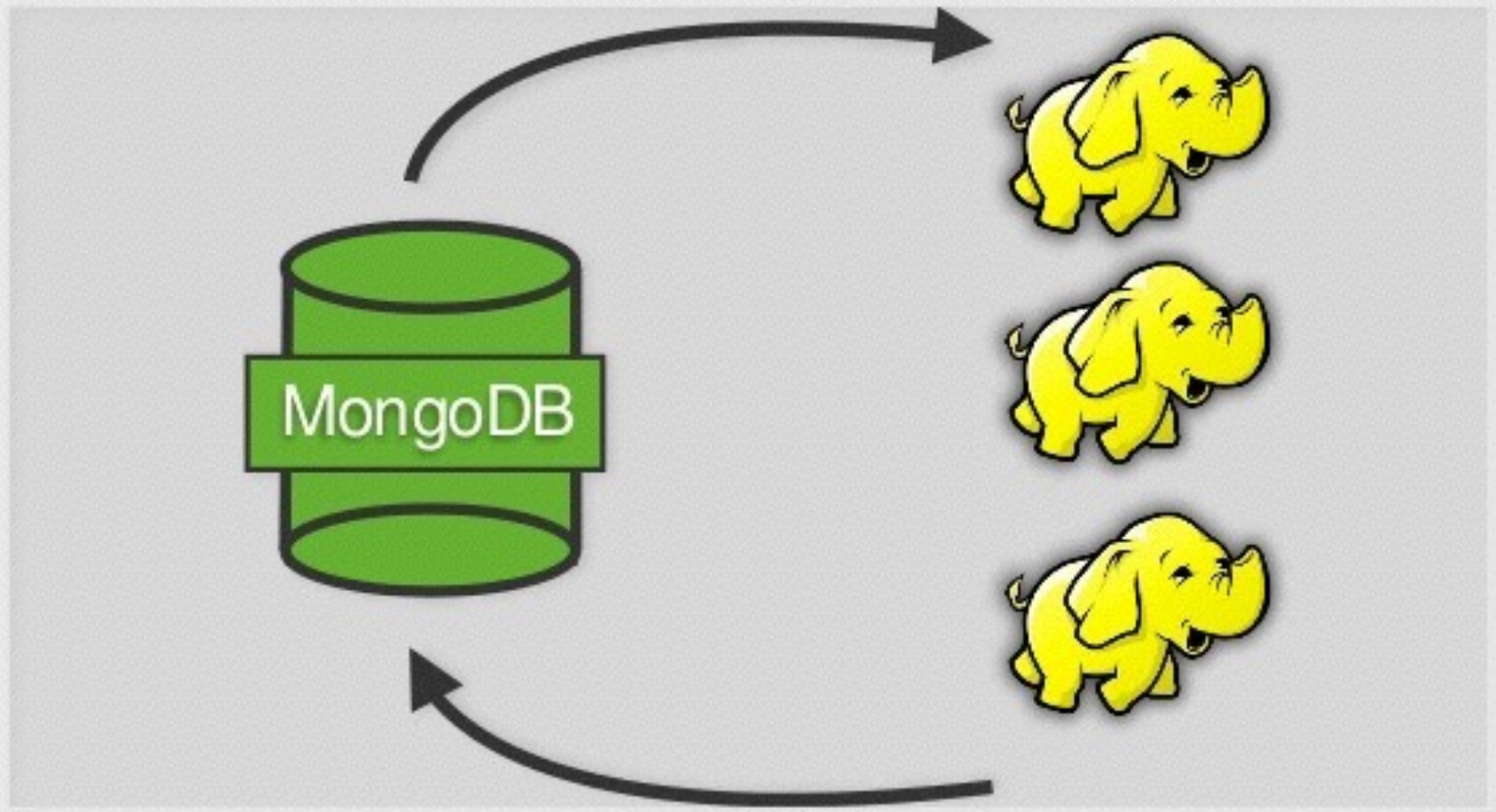
# Hadoop Connector




MongoDB with Hadoop

mongoDB

# Hadoop Connector




MongoDB with Hadoop

mongoDB

# Hadoop Connector

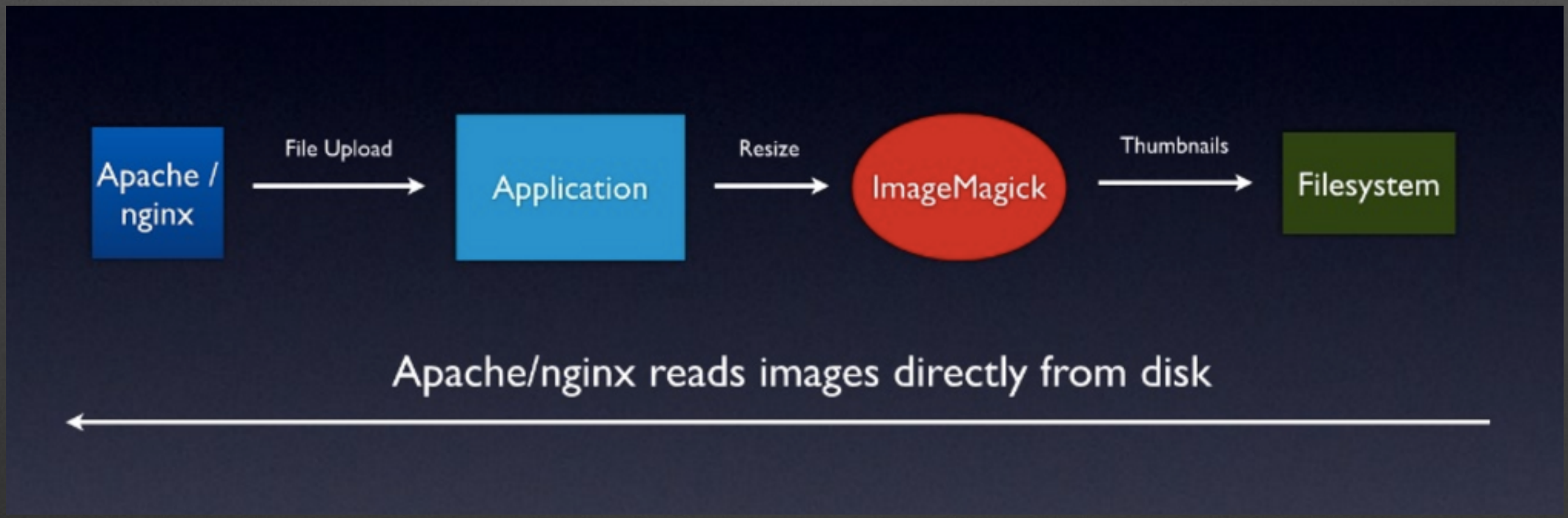
- Adapter가 MongoDB input Collection을 전달받아 data 조각(split)으로 나눔
- 각 조각이 하둡 노드에 할당
- 병렬 하둡 노드가 해당 데이터 조각(혹은 BSON)으로 프로세싱
- 연산 결과(output)을 MongoDB의 Collection에 저장

# Hadoop Connector

- FULL multi-core 병렬 연산
- FULL integration with Hadoop ecosystem
  - Pig, Hive…
- Amazon Elastic MapReduce && S3 || HDFS

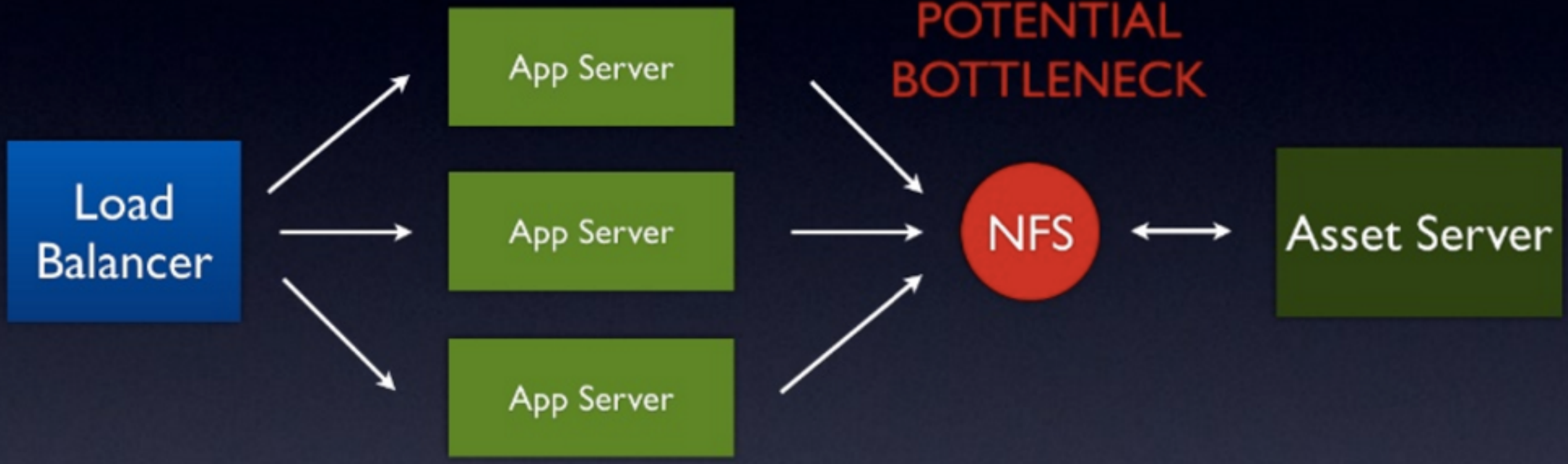
# GridFS

## Single Server Assets



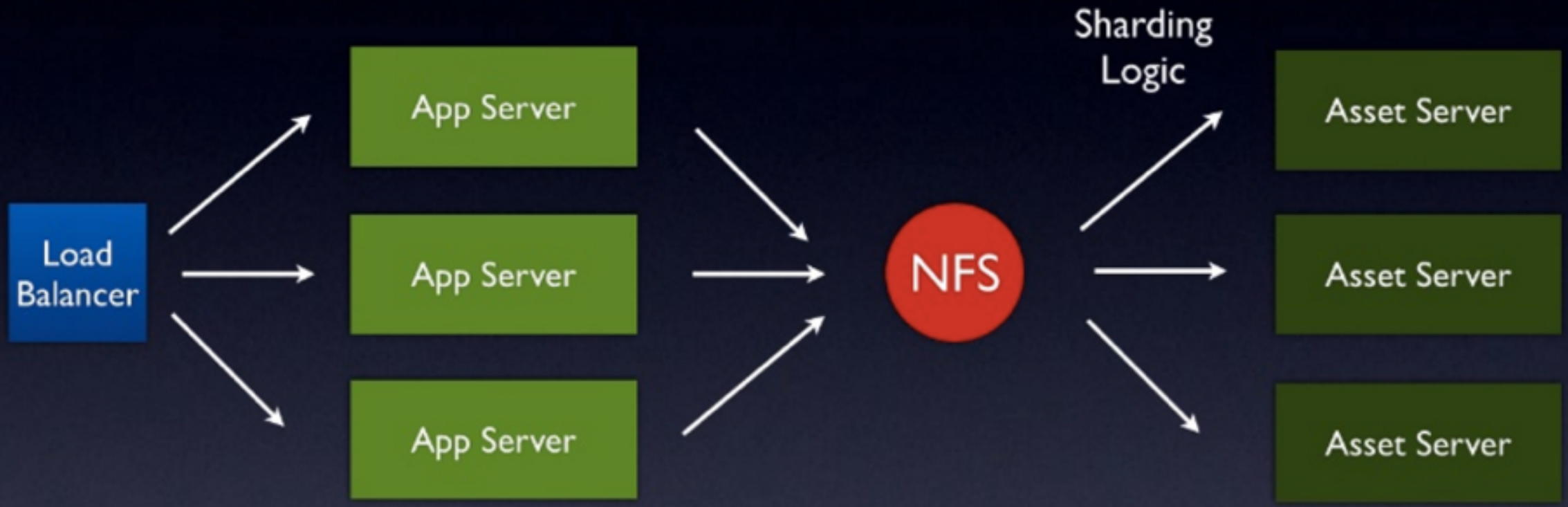
# GridFS

## Multi-Server Assets



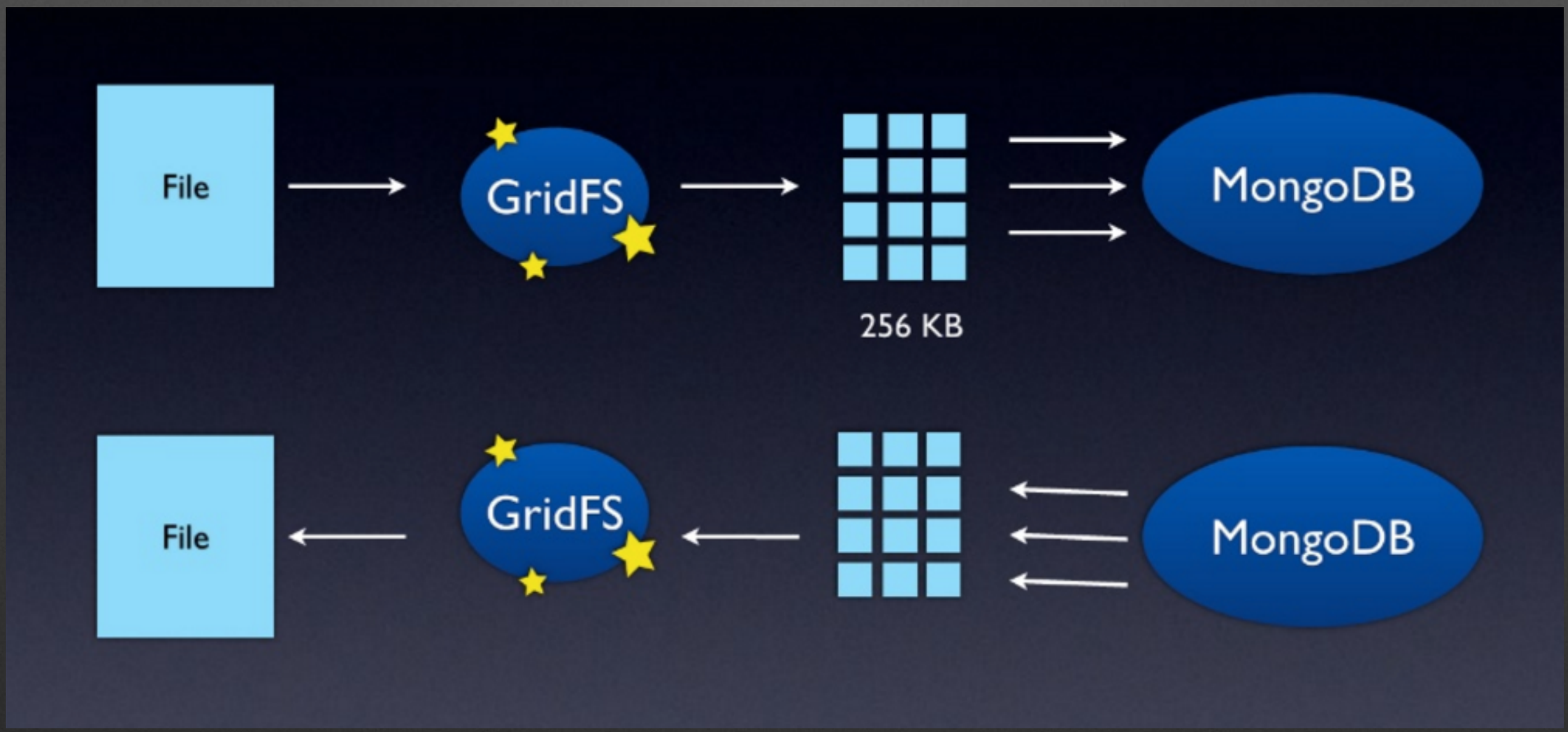
# GridFS

## Shareded Assets



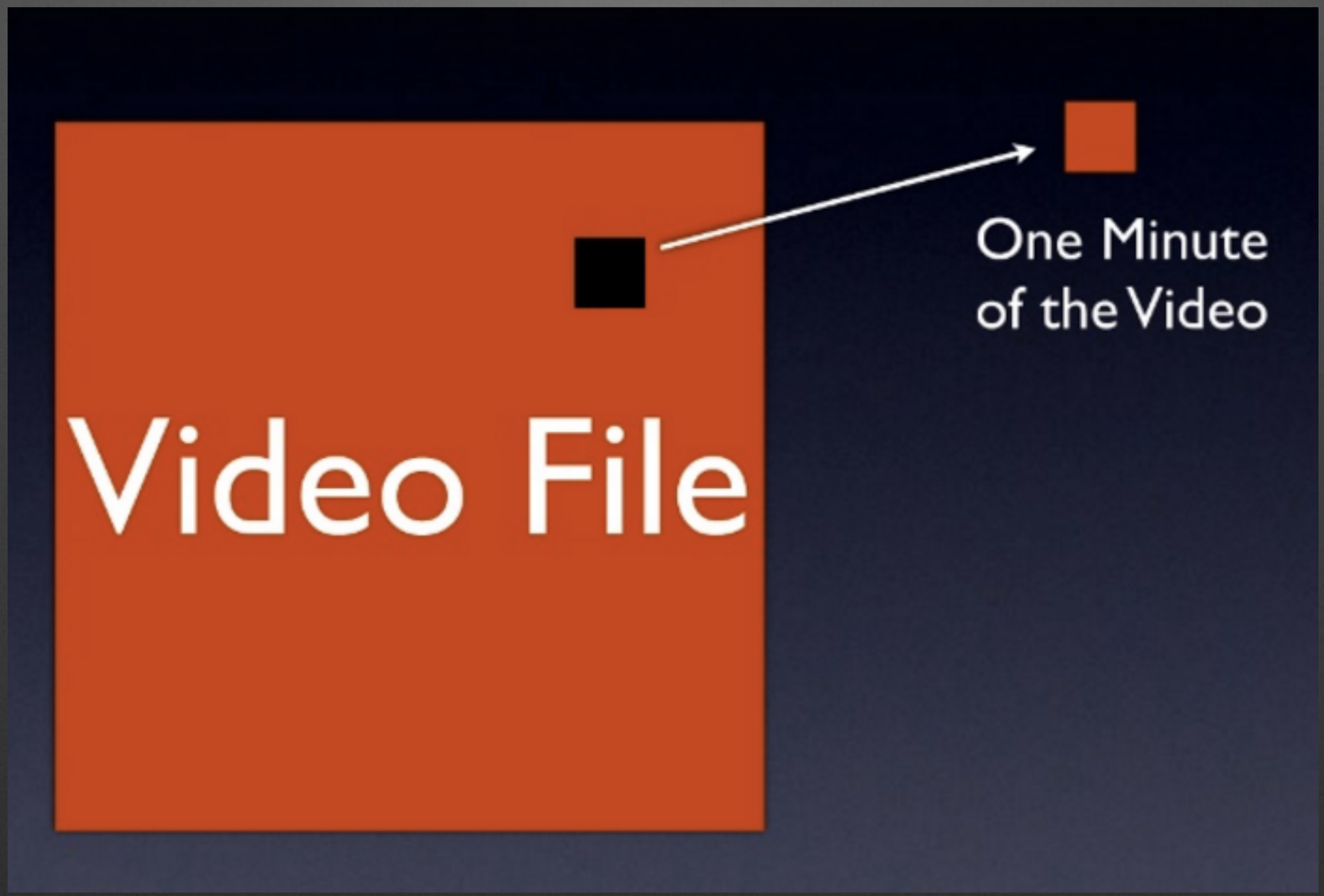
# GridFS

So, GridFS



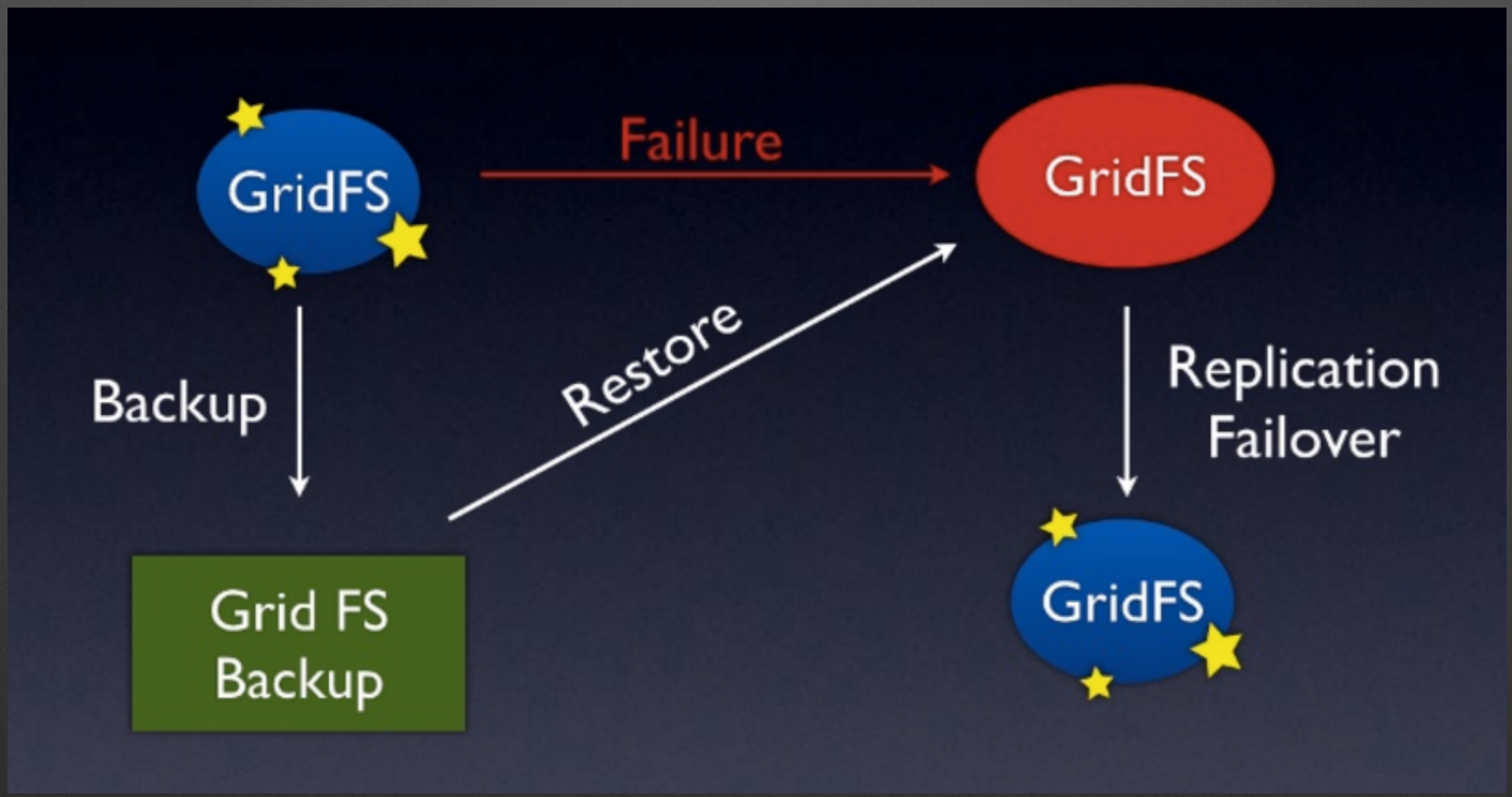
# GridFS

## Chunk Failover



# GridFS

## Chunk Recover



# When to use GridFS

1. Storing user generated file content
2. Accessing portions of file content
3. Storing documents greater than 16MB in MongoDB
4. Overcoming file system limitations

# GridFS Benchmark

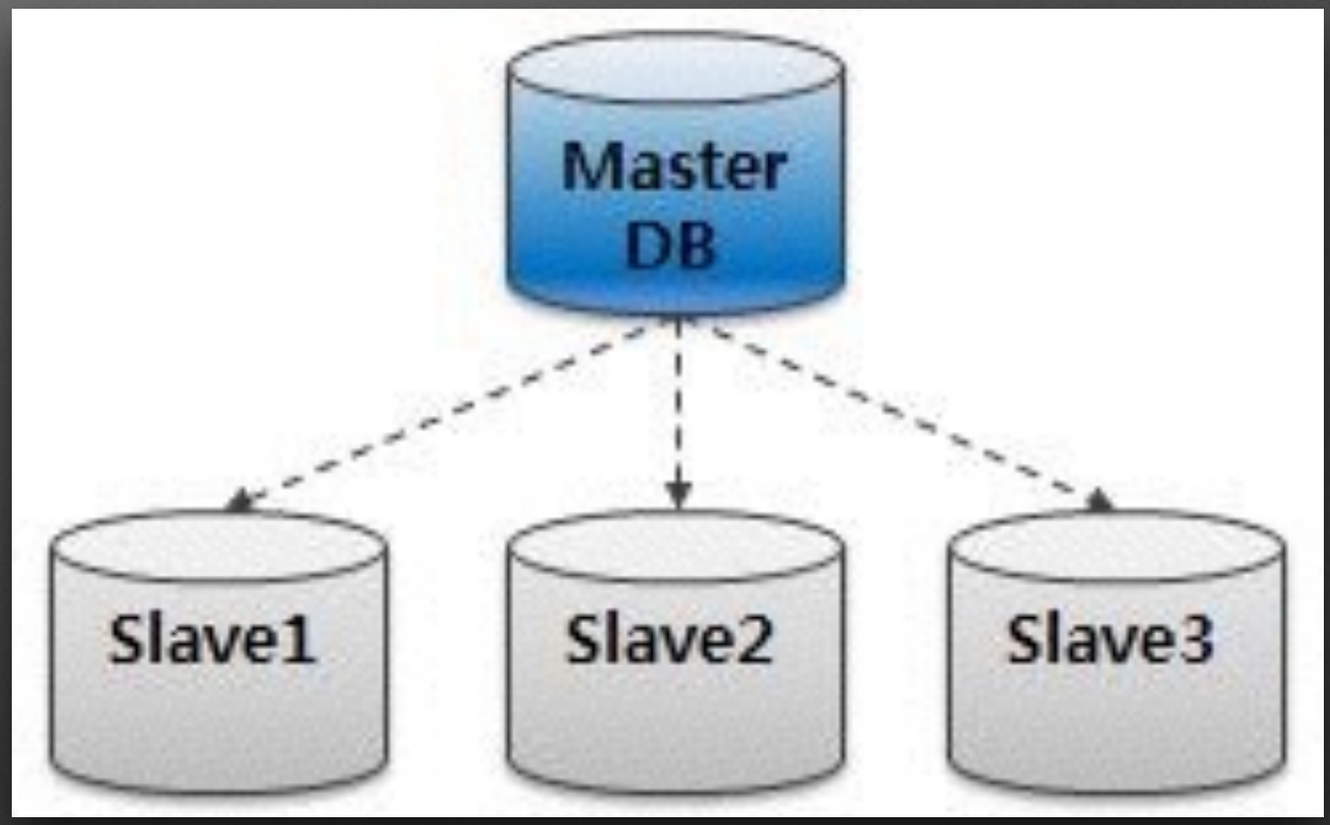
## Conclusion: Reasonable?!

| Solution | Requests/second | % Apache FS | % Nginx FS | % Nginx GridFS | % Apache Ruby |
|---|---|---|---|---|---|
| Filesystem via Apache | 2625.37 | - | 40.03% | 242.22% | 4,878.96% |
| Filesystem via Nginx | 6559.31 | 249.84% | - | 605.17% | 12,189.76% |
| GridFS via nginx module | 1083.88 | 41.28% | 16.52% | - | 2014.27% |
| Rails metal handler via Passenger | 53.81 | 2.05% | 0.82% | 4.96% | - |

https://www.coffeepowered.net/2010/02/17/serving-files-out-of-gridfs/

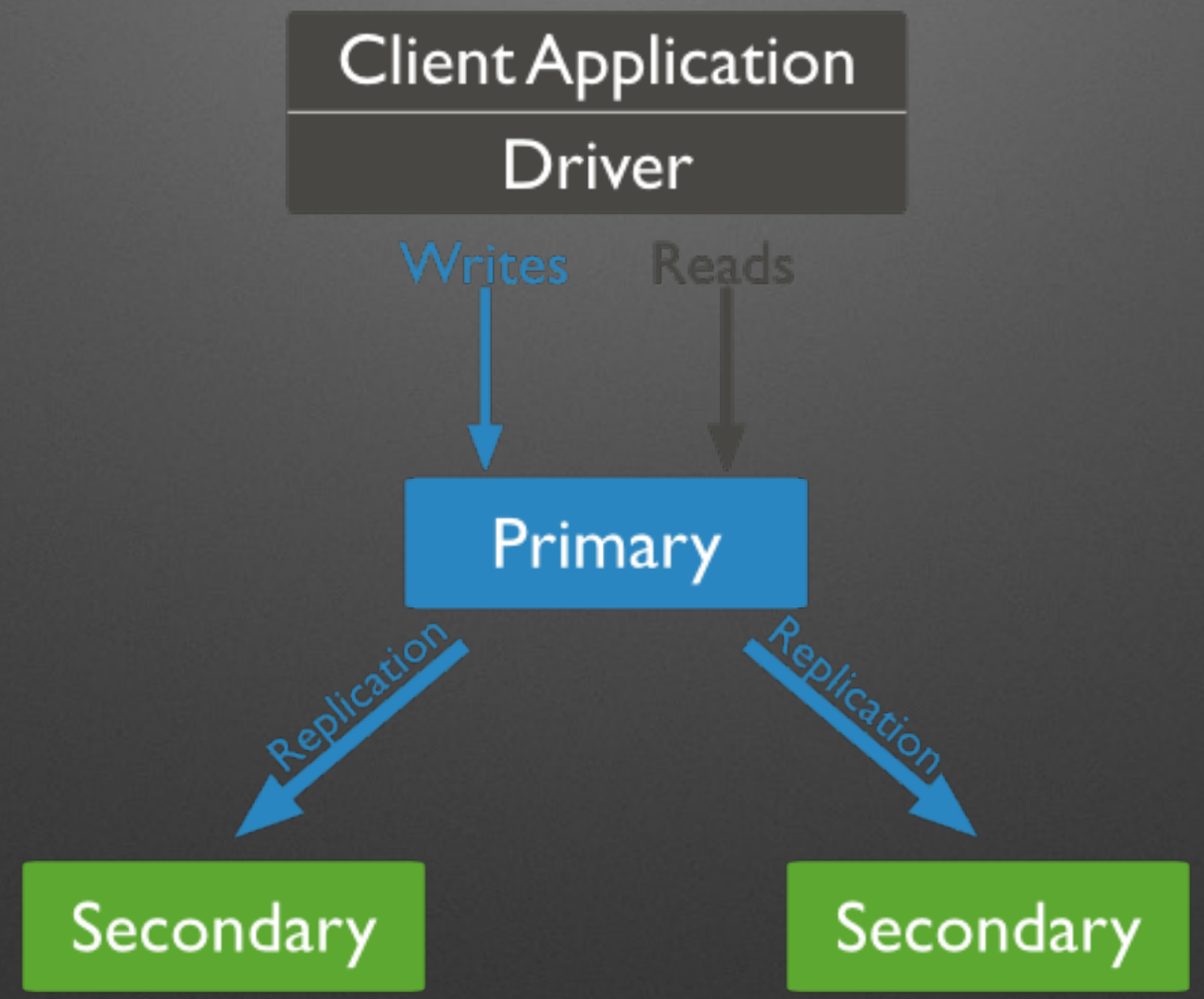
# Master-Slave

- 일반적인 Master/Slave 구조
- 읽기 부하 분산
  - Slave는 Read-Only




- Master에 Write 부하 증가
- Master Fail 대응 HA 별도 조치 필요

# Replica Sets




https://docs.mongodb.org/v3.0/core/replica-set-members/

# Replica Sets

- 동적인 Master Vote 자동 처리
- Master Fail시 Priority에 따른 투표를 통해 Master 대체
- 장애 서버는 복구 후 다시 보조 서버로 편입
- Priority가 0인 후보 서버는 Master 불가 = 백업서버

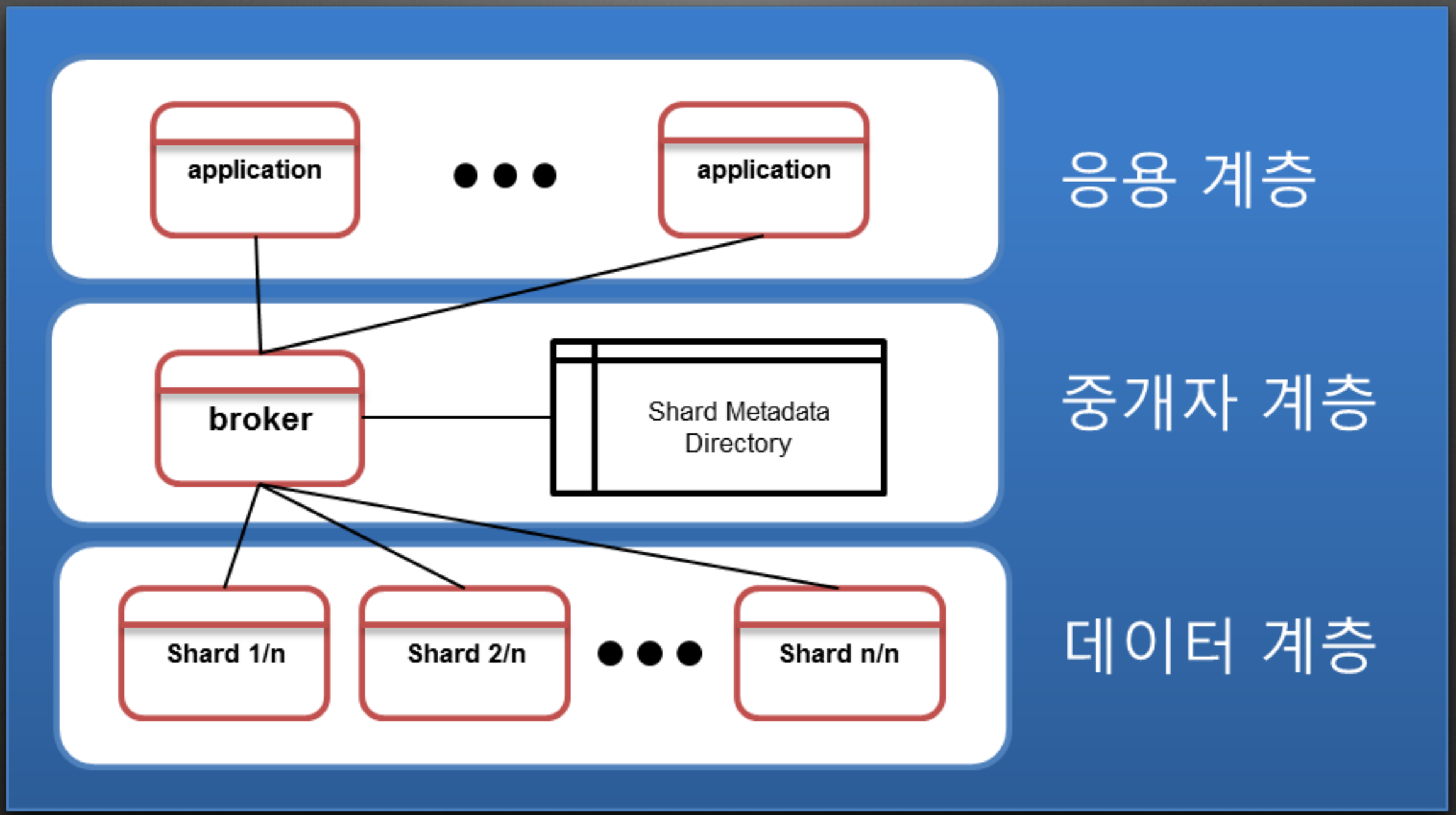
https://docs.mongodb.org/v3.0/core/replica-set-members/

# Slave 활용

- 데이터 유실이나 마스터 노드에서 장애 발생시 요청 넘김
- 백업
- 읽기 부하 분산
- 통계 등 데이터 처리용 업무 수행

- Writing에 대한 부하 분산은 불가능

# Shard Architect

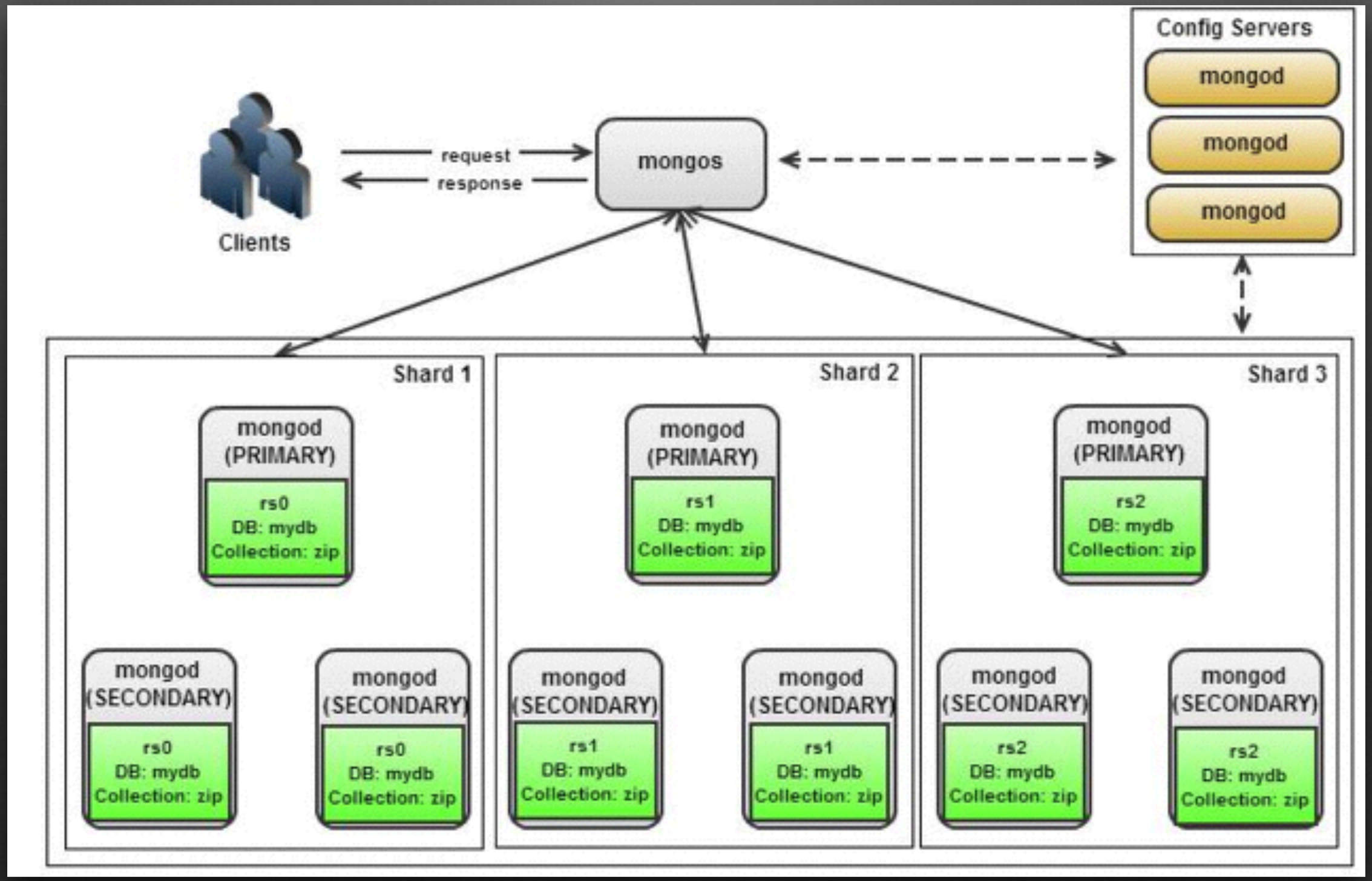



http://mongodb.citsoft.net/?page_id=225

# 3-Way Broker

- 형태에 따른 분류
  - 데이터 유형에 따른 테이블 분류
  - 테이블이 분할되지 않으므로 독립성 보장된 쿼리에서 높은 성능
- 키 기반 분류
  - Shard-Key에 따른 분류 (auto/manual)
- Look-Up 테이블 기반 분류
  - Shard-Key의 해쉬값을 통한 랜덤 균등 분할 정책

# Shard Architect




http://dba.stackexchange.com/questions/82551/data-distribution-in-mongos-with-shards-or-replica-sets

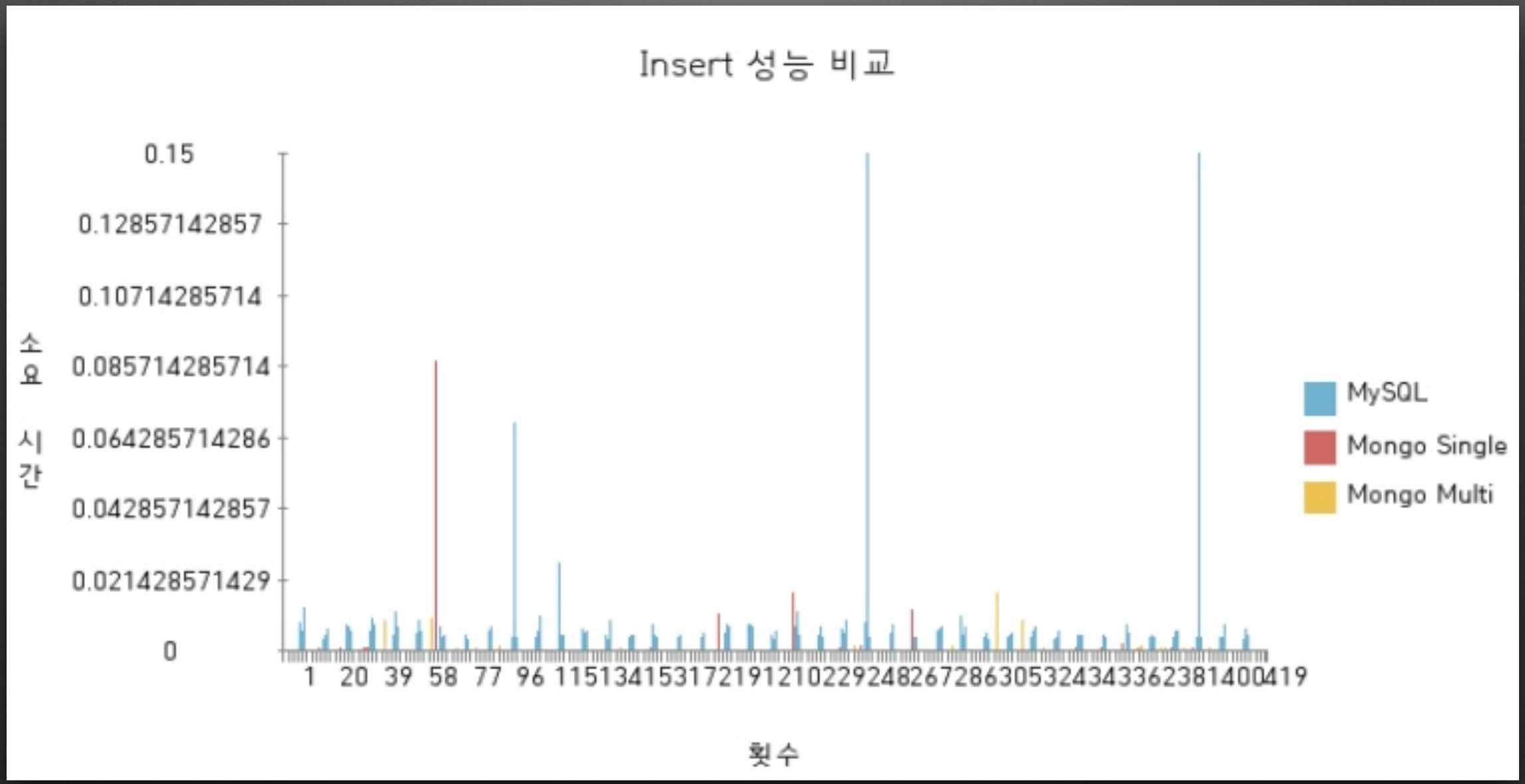
# Sharding Condition

- 쓰기(DB Write)가 빈번 할 경우
- 현재 장비에 디스크 공간이 부족할 경우
- 애플리케이션에 영향을 주지 않고 증가하는 부하와 데이터를 처리하기 위해 장비 추가. 즉, Scale-Out

# Shard 유의점

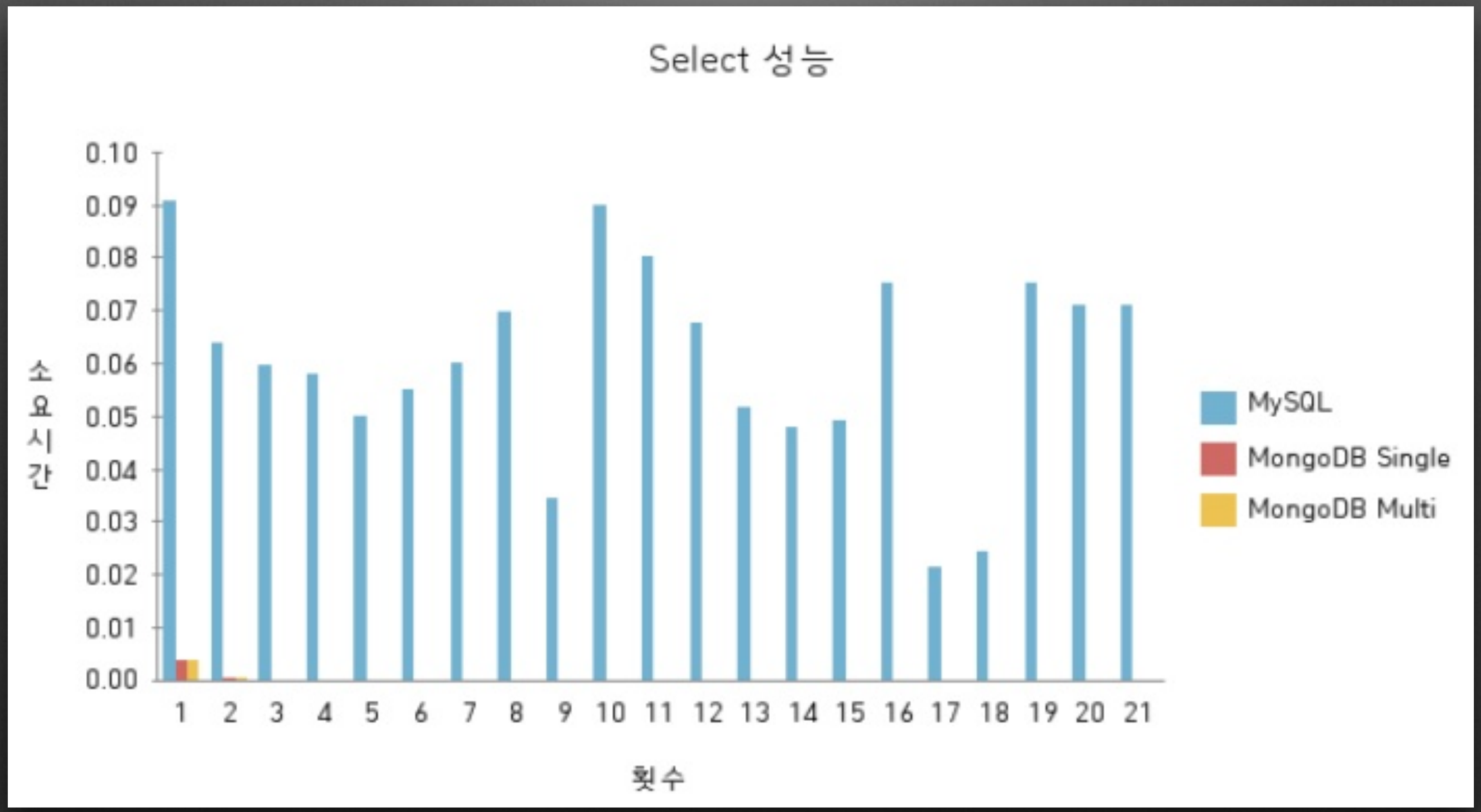
- Fragmentation
  - 단편화, 조각화 문제
  - 빈번한 삭제나 업데이트는 단편화를 발생시키고, 실제 데이터 보다 훨씬 많은 메모리를 사용 함
  - 데이터 삭제 또는 이전해도 사용량은 그대로 유지
  - repairDatabase를 통해 복구 해야함

# MongoDB vs MySQL

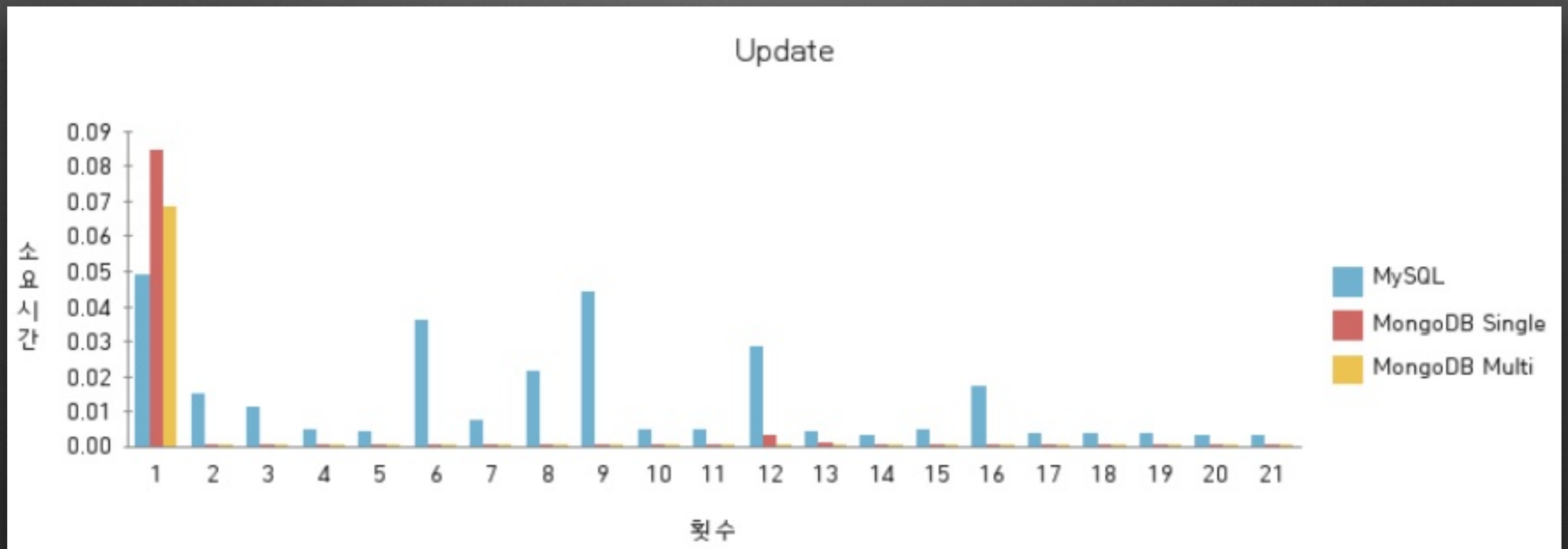



I love MySQL!

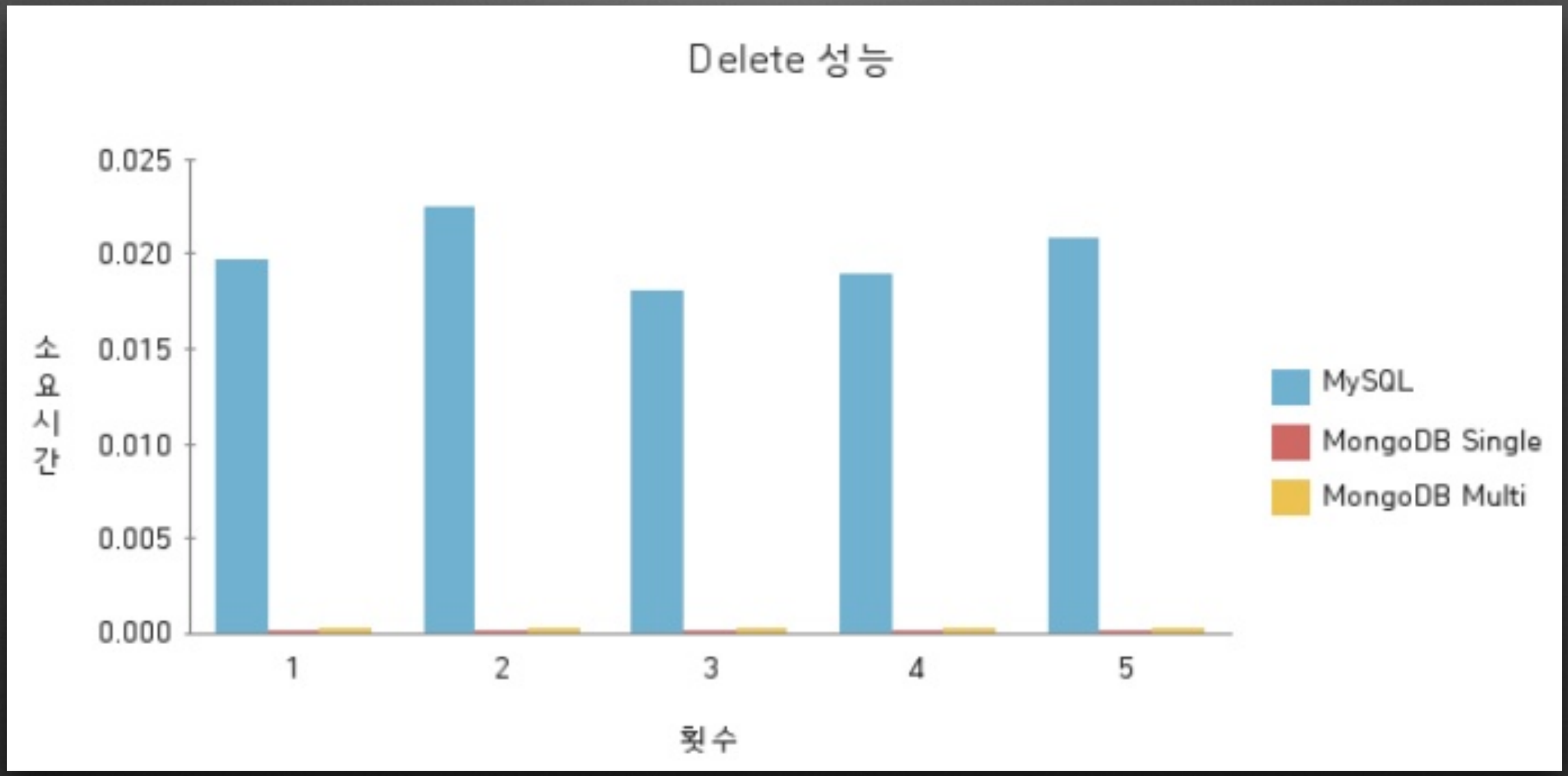
# MongoDB vs MySQL



# MongoDB vs MySQL



# MongoDB vs MySQL



# MongoDB 활용 유의사항

- 미친듯이 테스트 하라 – Test exhaustively
- RDBMS를 그대로 대체할 수 있다고 가정하지 말라 – Don't assume that what worked for your RDBMS will translate
- 데이터에 대한 일관성과 안전성이 필요한지 고민하라 – Think about the consistency and durability needs of your data

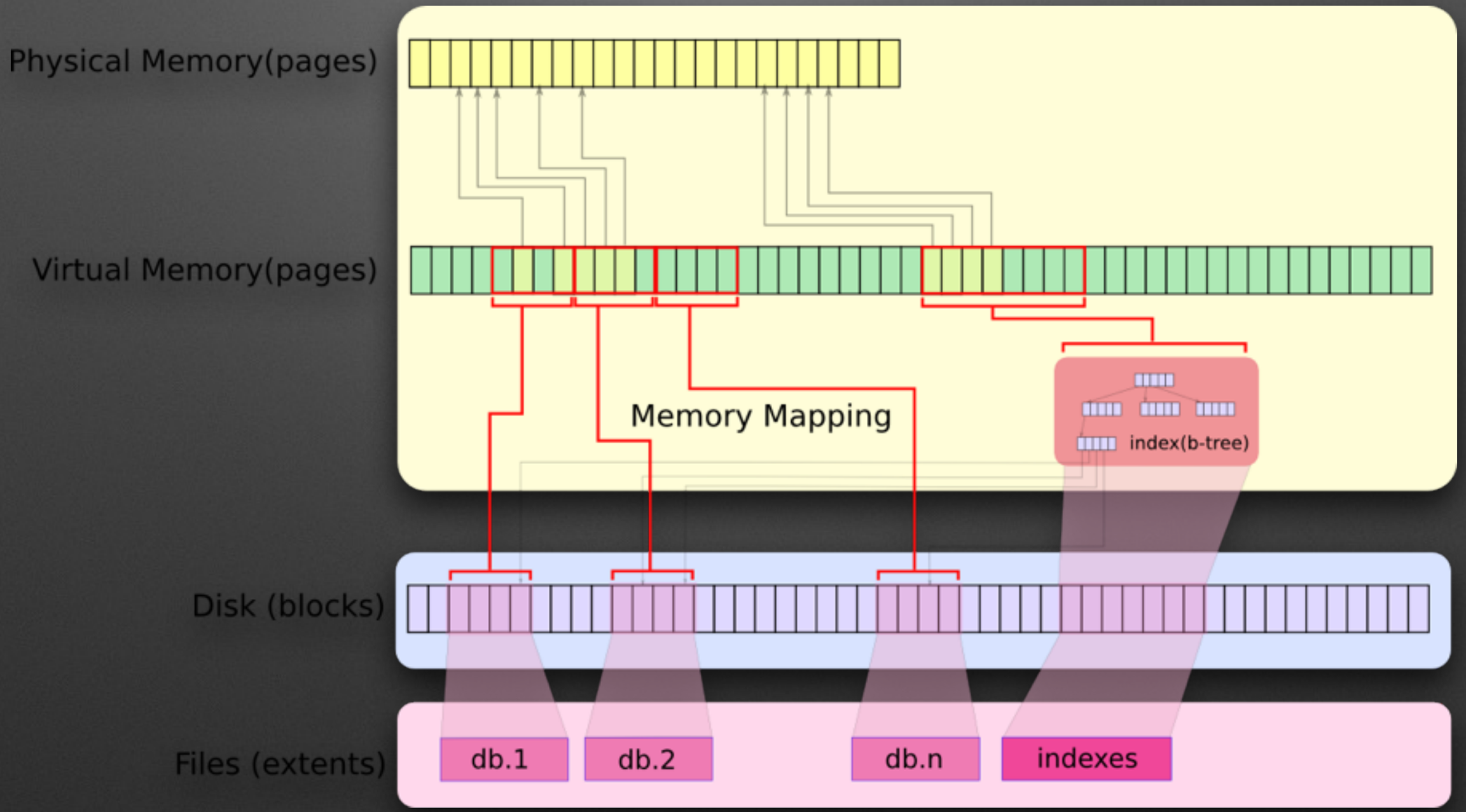
# MongoDB 활용 유의사항

- 항상 Replica Sets을 사용하라 – Always use replica sets
- 최신 버전을 유지하라 – Keep current with versions
- MongoDB를 32bit에서 사용하지 말라 – Don’t run MongoDB on 32-bit systems
- 기본적으로 Journaling을 사용하라 – Turn journaling on by default

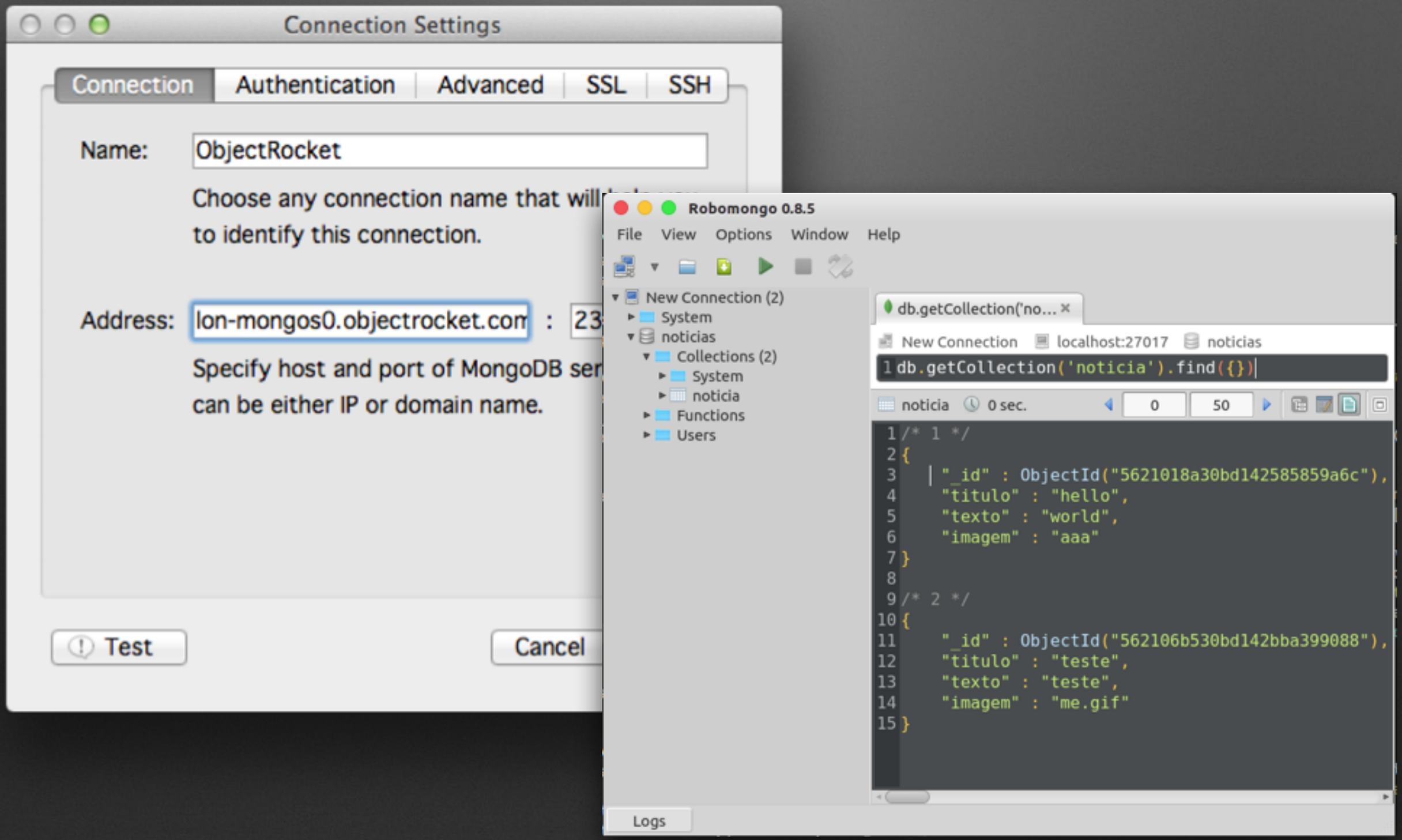
# MongoDB 활용 유의사항

- 데이터 파일의 위치를 확인하라 – Mind the location of your data files
- Working Set은 메모리 사이즈에 적합하게 유지하라 – Your working set should fit in memory
- 엄청 많이 사용한다면 Scale Up을 하라 – Scale up if your metrics show heavy use
- 샤딩에 주의하라 – Be careful when sharding

# MongoDB 활용 유의사항



# RoboMongo


Connection Settings
Connection
Authentication
Advanced
SSL
SSH
Name:
ObjectRocket
Choose any connection name that will
to identify this connection.
Address:
lon-mongos0.objectrocket.com
23
Specify host and port of MongoDB ser
can be either IP or domain name.
Test
Cancel
Robomongo 0.8.5
File
View
Options
Window
Help
New Connection (2)
System
noticias
Collections (2)
System
noticia
Functions
Users
db.getCollection('no...
New Connection
localhost:27017
noticias
db.getCollection('noticia').find({})
noticia
0 sec.
0
50
/* 1 */
{
"_id" : ObjectId("5621018a30bd142585859a6c"),
"titulo" : "hello",
"texto" : "world",
"imagem" : "aaa"
}
/* 2 */
{
"_id" : ObjectId("562106b530bd142bba399088"),
"titulo" : "teste",
"texto" : "teste",
"imagem" : "me.gif"
}
Logs

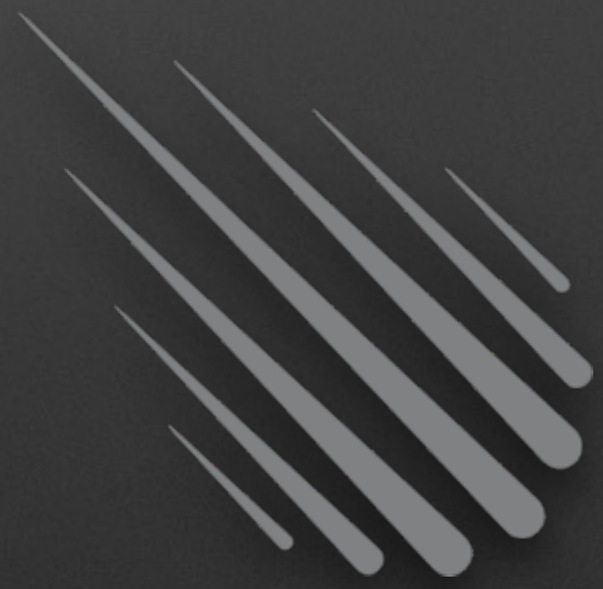
# Conclusion

## 조심히 쓸만하다

안되면 아키 탓

# Meteor.js
# with MongoDB

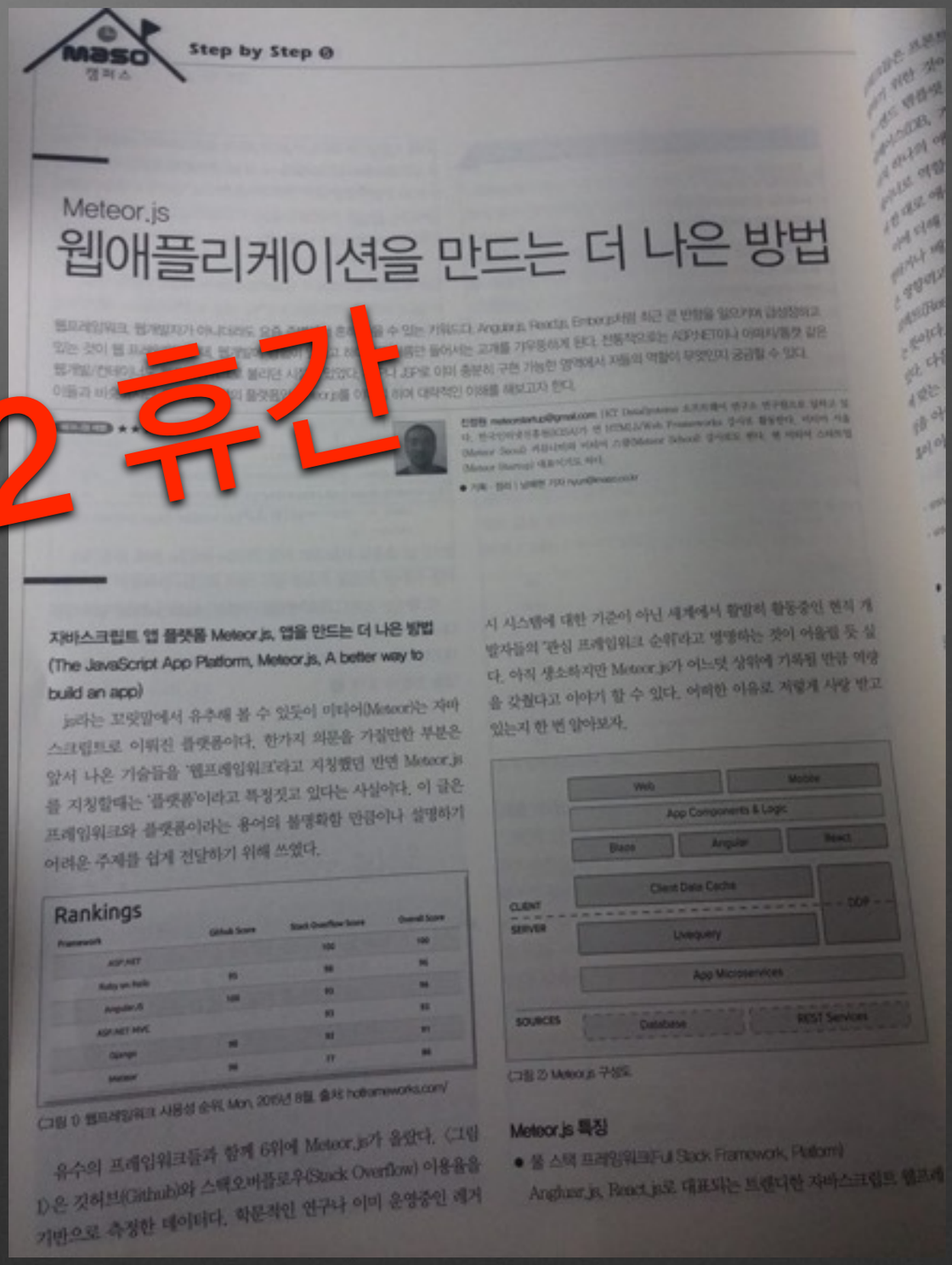
A better way to build a web application



# A better way to build a web

- 2015.11 기고

2015.12 유신



Step by Step

Meteor.js
웹애플리케이션을 만드는 더 나은 방법

자바스크립트 앱 플랫폼 Meteor.js, 앱을 만드는 더 나은 방법
(The JavaScript App Platform, Meteor.js, A better way to build an app)

Rankings

그림 1 웹프레임워크 사용성 순위, Mon, 20thst 8월, 출처: hotframeworks.com/

그림 2 Meteor.js 구성도

Meteor.js 특징

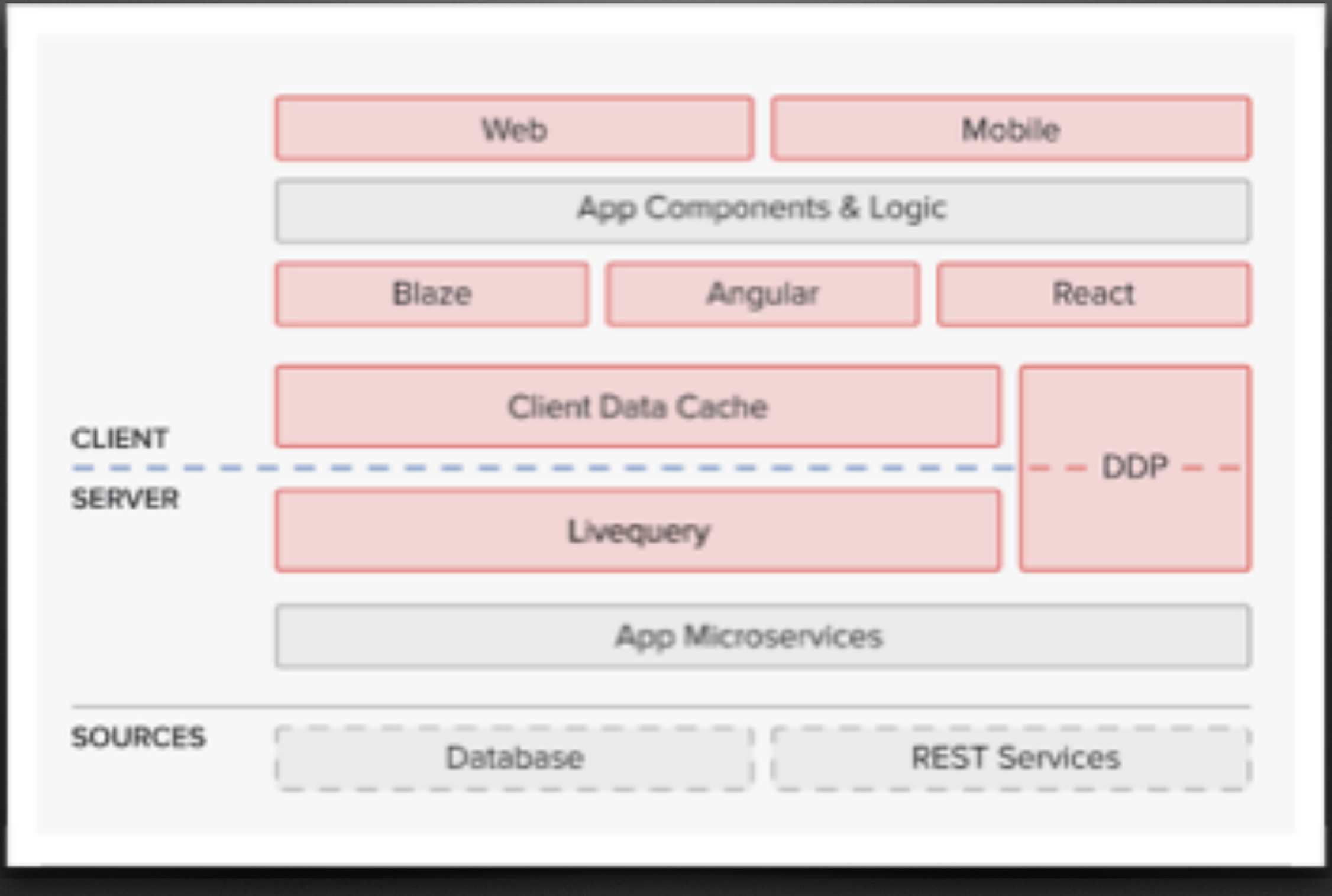
# Meteor.js

## Rankings

| Framework | Github Score | Stack Overflow Score | Overall Score |
|---|---|---|---|
| ASP.NET | | 100 | 100 |
| Ruby on Rails | 95 | 98 | 96 |
| AngularJS | 100 | 93 | 96 |
| ASP.NET MVC | | 93 | 93 |
| Django | 90 | 92 | 91 |
| Meteor | 96 | 77 | 86 |

http://hotframeworks.com/

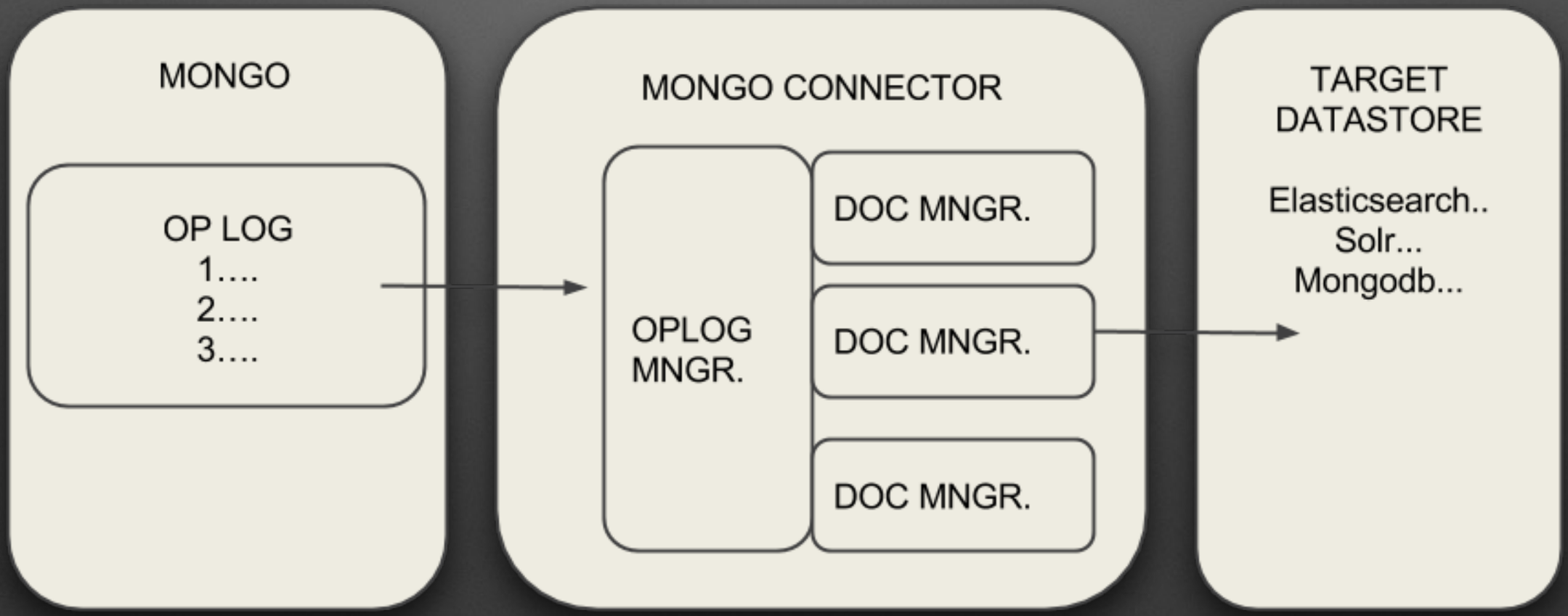
# Meteor.js


Web
Mobile
App Components & Logic
Blaze
Angular
React
Client Data Cache
CLIENT
DDP
SERVER
Livequery
App Microservices
SOURCES
Database
REST Services

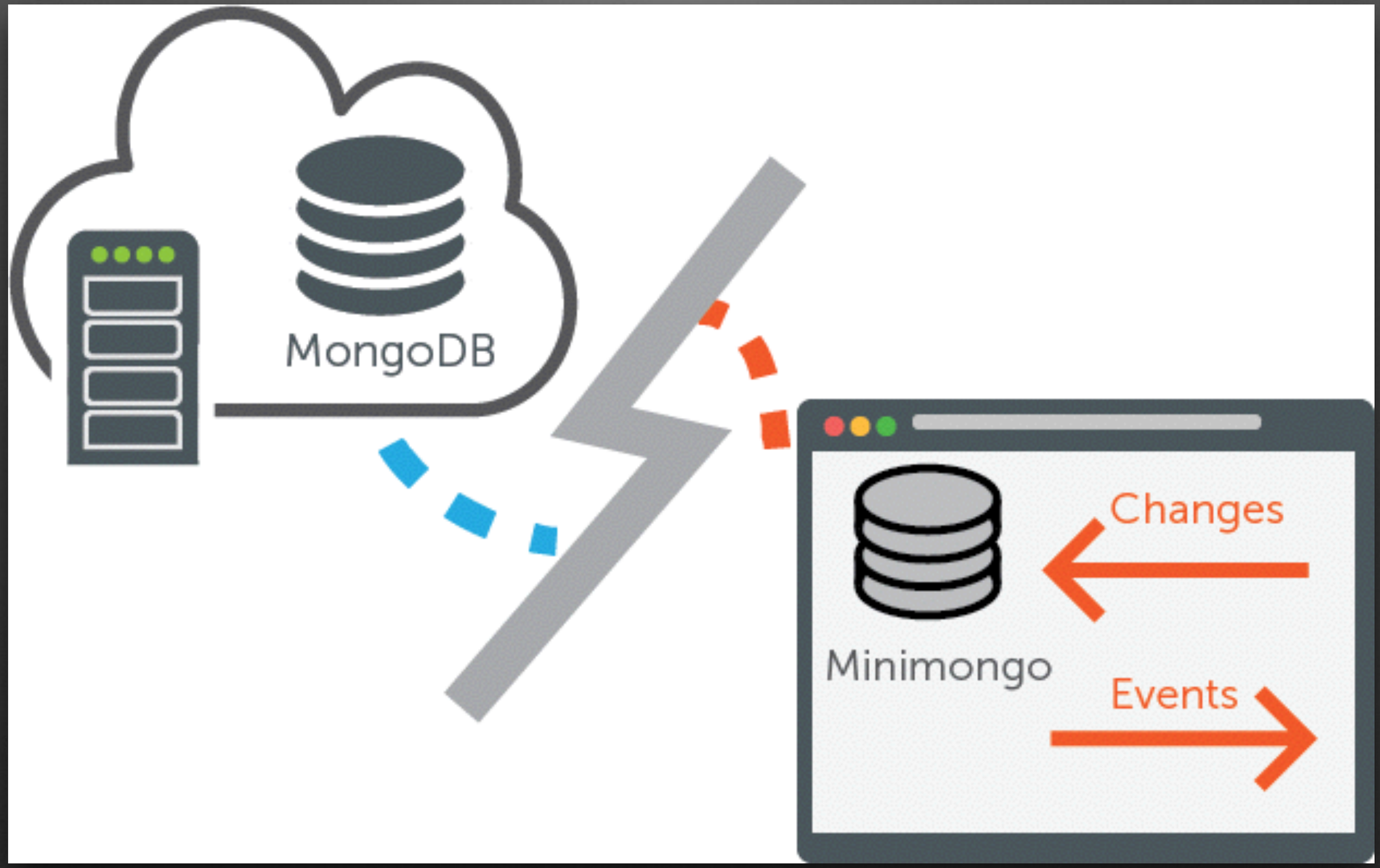
# Benefits

- Full Stack Framework (Platform)
- Full javascript
- Easy Install / Usage / Package / Deployment
- Auto Install with MongoDB
  - Reactive
  - Latency Comprehension

# Reactive with OPLOG



# Latency Comprehension



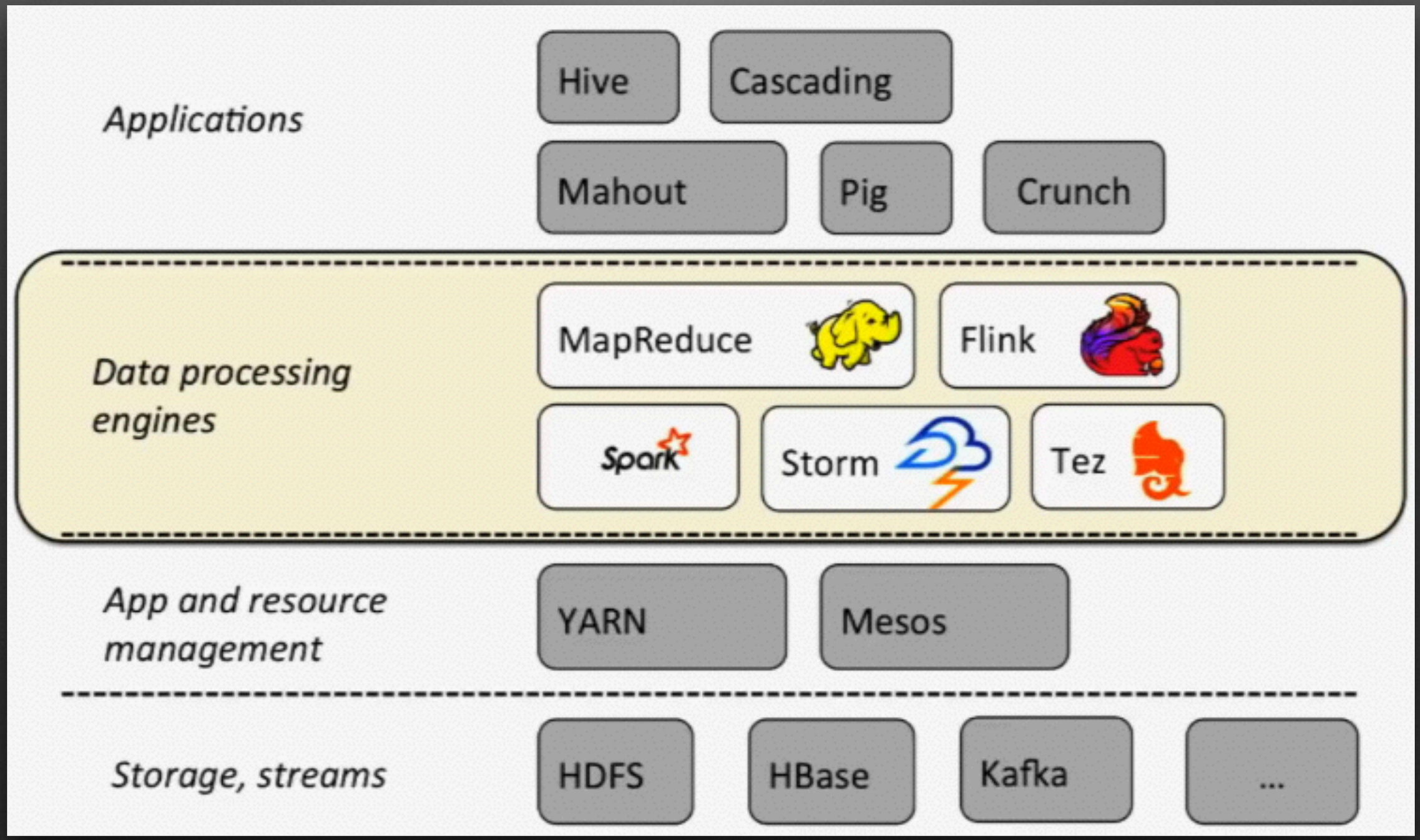
# Spark

# Overview

- 범용적 목적의 분산 고성능 클러스터링 플랫폼
  (General purpose high performance distributed platform)
- Map & Reduce (cf. Hadoop)
- Streaming 데이타 핸들링 (cf. Apache Storm)
- SQL 기반의 데이타 쿼리 (cf. Hadoop의 Hive)
- 머신 러닝 라이브러리 (cf. Apache Mahout)

어차피 여기저기서 맹 듣는 소리들

# Spark in Hadoop

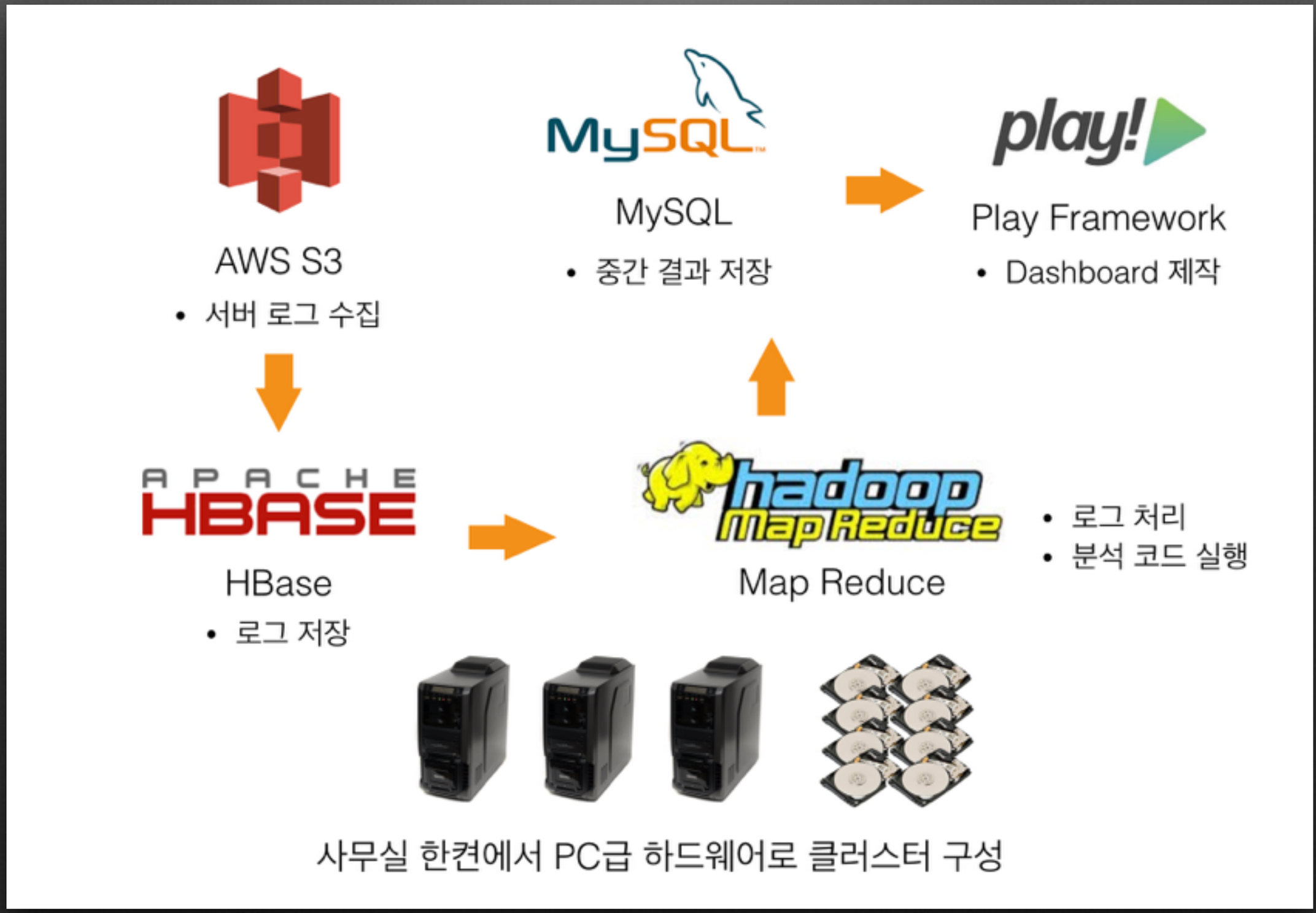



http://www.nextplatform.com/2015/02/22/flink-sparks-next-wave-of-distributed-data-processing/

# General Hadoop Process

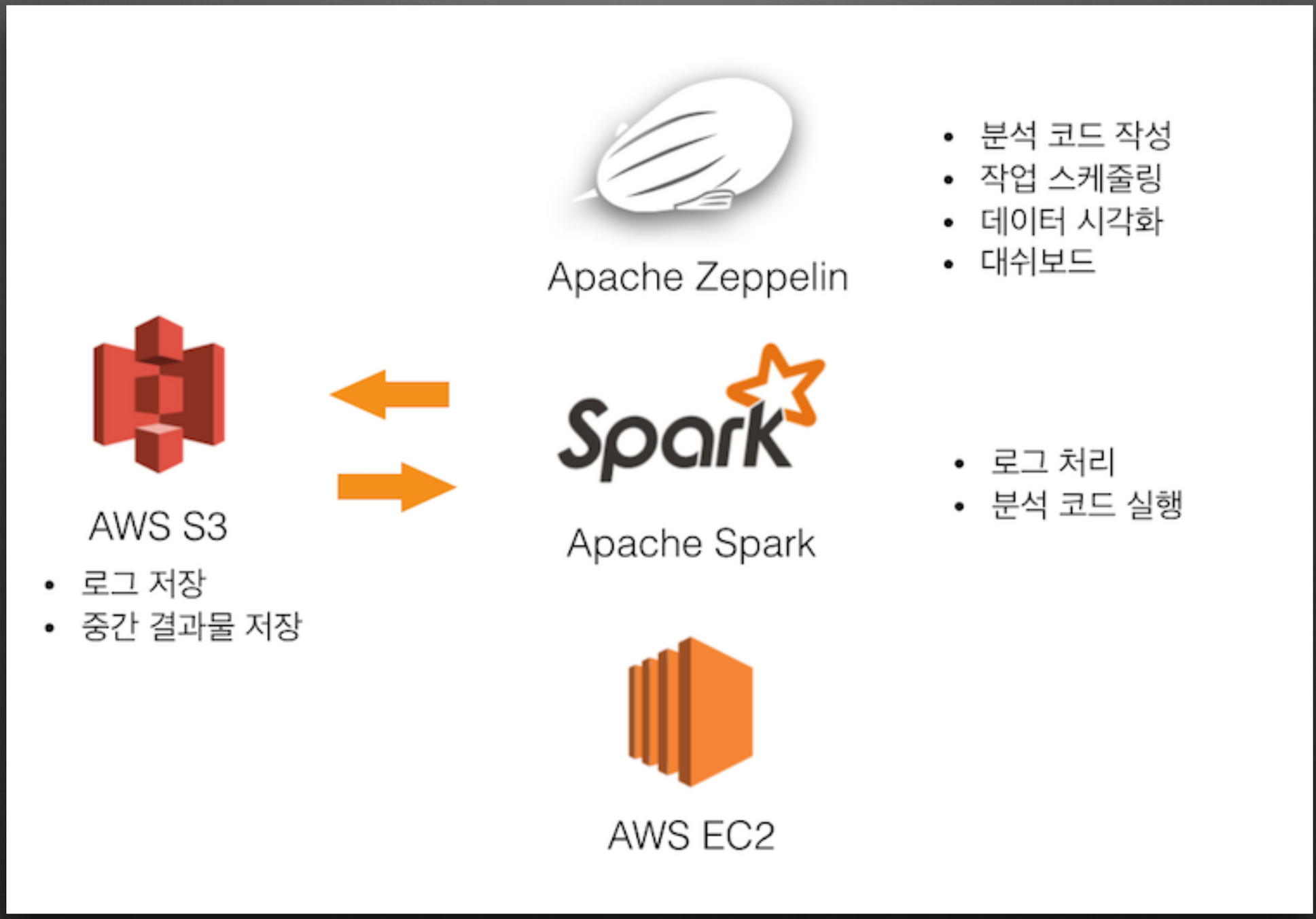
- ETL로 데이터 로딩
- MR로 데이터 정체
- RDBMS, NoSQL로 구성된 OLAP등의 시스템에 임시 저장
- Storm 등으로 실시간 분석
- 리포팅 툴로 그래프 표현

# VCNC Hadoop Arch.




http://engineering.vcnc.co.kr/2015/05/data-analysis-with-spark/

# VCNC Spark Arch.




http://engineering.vcnc.co.kr/2015/05/data-analysis-with-spark/

# Hadoop VS Spark

| | 기존(Hadoop) | 현재(Spark) |
|---|---|---|
| 일일 배치 분석 | 코드 작성 및 관리가 어려움 | Zeppelin의 Schedule 기능을 통해 수행<br>Interactive shell로 쉽게 데이터를 탐험<br>오류가 생긴 경우에 shell을 통해 손쉽게 원인 발견 및 수정 가능 |
| Ad-hoc(즉석) 분석 | 복잡하고 많은 코드를 짜야 함<br>분석 작업에 수 일 소요 | Interactive shell 환경에서 즉시 분석 수행 가능 |
| Dashboard | 별도의 사이트를 제작하여 운영<br>관리가 어렵고 오류 대응 힘듦 | Zeppelin report mode 사용해서 제작<br>코드가 바로 시각화되므로 제작 및 관리 수월 |
| 성능 | 일일 배치 분석에 약 8시간 소요 | 메모리를 활용하여 동일 작업에 약 1시간 소요 |

http://engineering.vcnc.co.kr/2015/05/data-analysis-with-spark/

# Spark Pros.

- Include (almost) all of Hadoop Stack
- Speed
- Language: Scala, JAVA, Python, R …
- DB: HDFS, S3, Cassandra, MongoDB …

# SQL on Hadoop vs Spark

- SQL on Hadoop(Hive, 타조, 임팔라)은 SQL에 친숙한 사용자를 타겟팅
- Spark는 복잡한 Map-Reduce에 지친 사용자들이 주요 타겟팅

# Language Diff

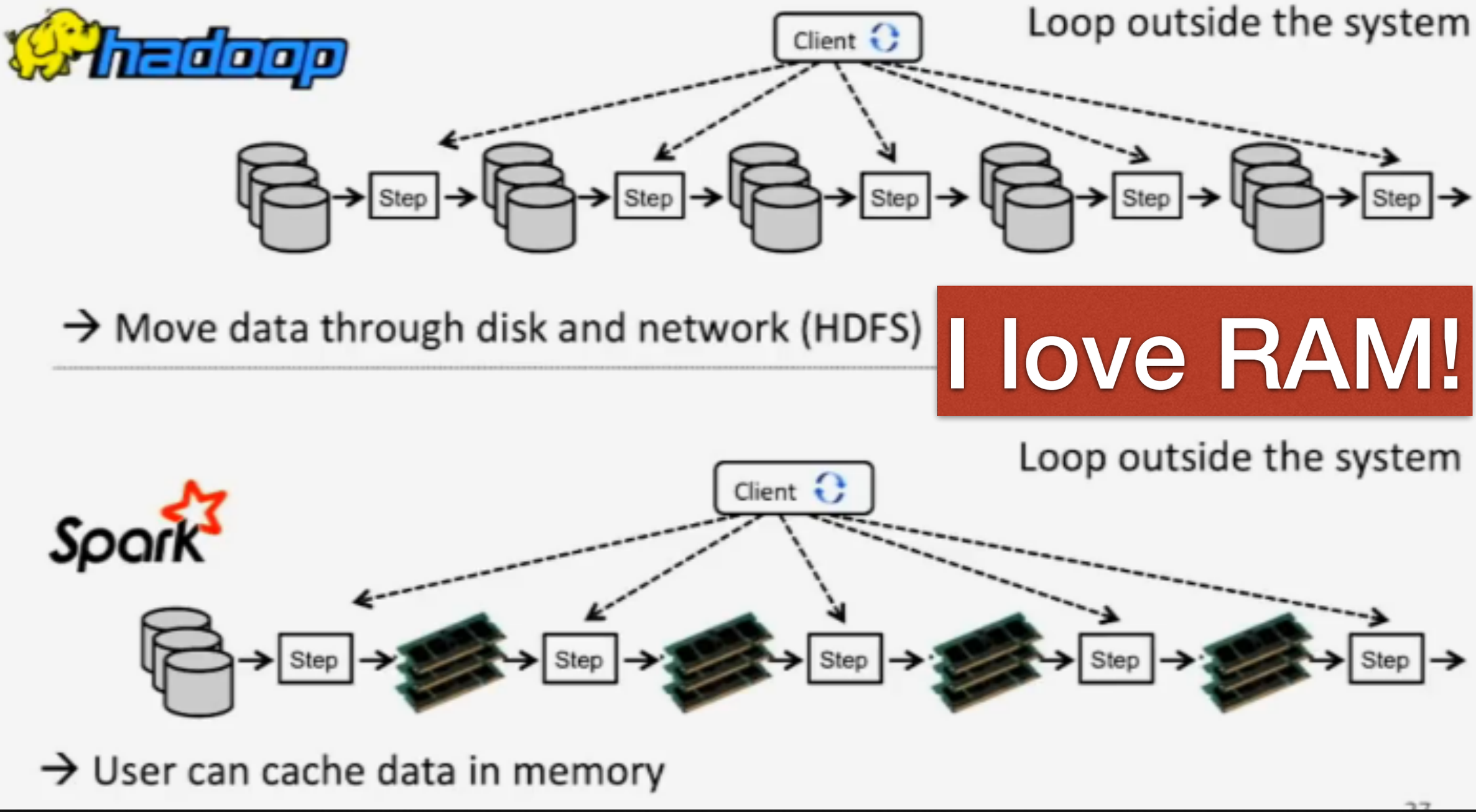
- Closure in Python
  lines = sc.textFile(…)
  lines.filter(lambda s: "ERROR" in s).count()

- Closure in Scala
  val lines = sc.textFile(...)
  lines.filter(s => s.contains("ERROR")).count()

- Closure in JAVA
  JavaRDD lines = sc.textFile(...);
  lines.filter(new Function<String, Boolean>()  {
    Boolean call(String s) {
      return s.contains("error");
    }
  }).count();

I love Java!

# Iteration of Spark & Hadoop

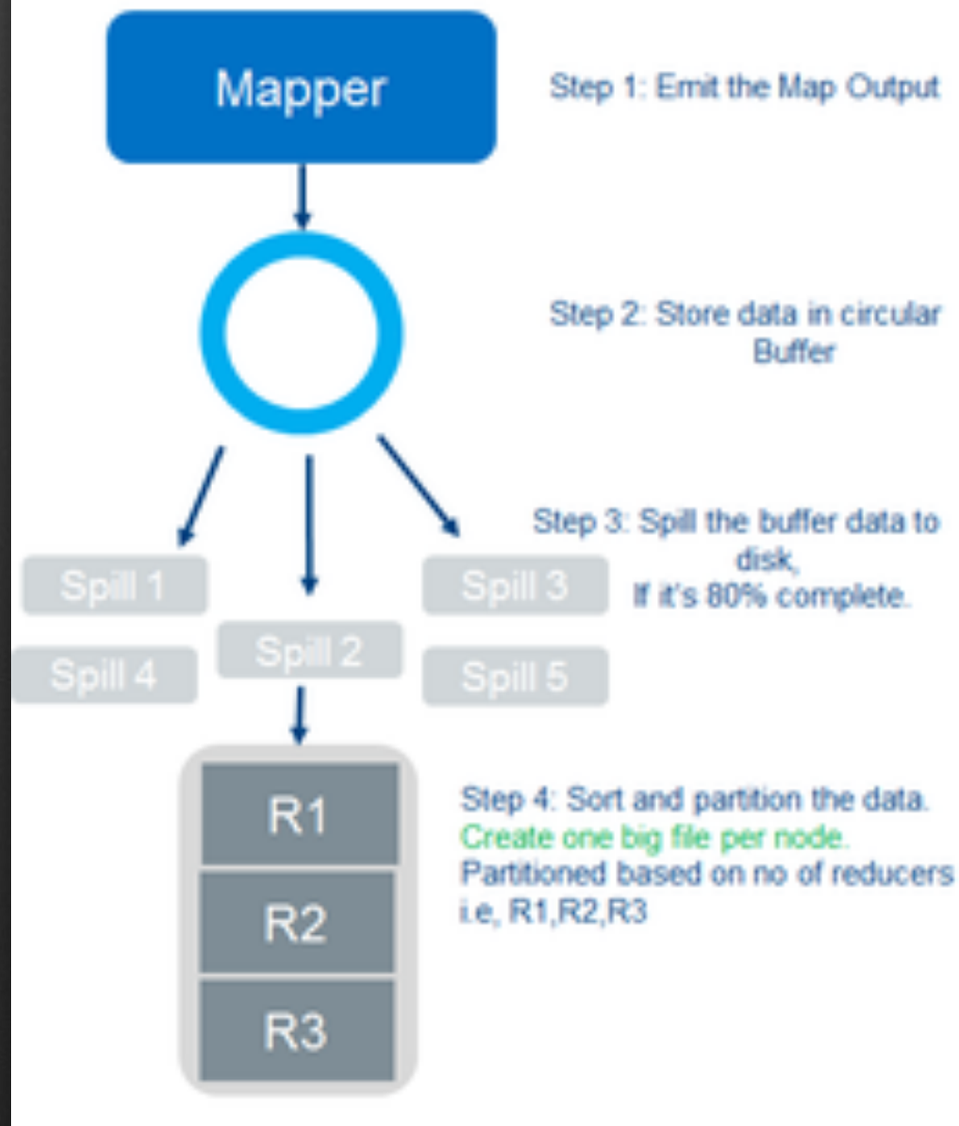



http://www.nextplatform.com/2015/02/22/flink-sparks-next-wave-of-distributed-data-processing/

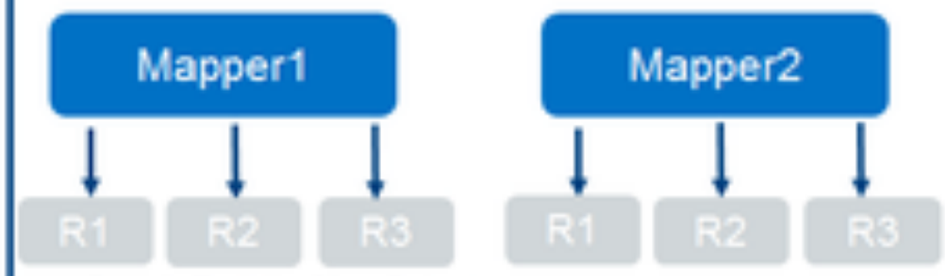
# Map, vs Hadoop

## Map side - Shuffle Phase Differences…

### In Hadoop

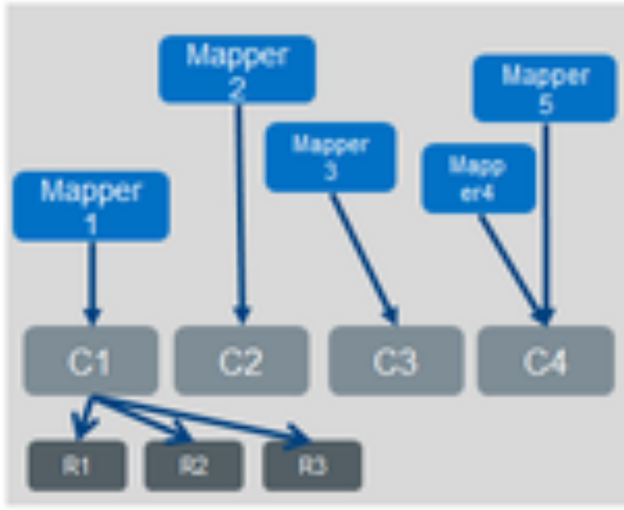



### In SPARK: Initial design




- Step 1: Emit the Map Output
- Step 2: Create R(Reducer) shuffle files per Mapper. Data usually stay In OS Buffer Cache. Some written to disk. Hence the Write/Read is at memory speed.
- Eg: if M = 2000 and R = 6000 i.e 2000*6000=12 million Around 12 Million Shuffle files !! Performance Problems.

### In SPARK: Shuffle File Consolidation




R=Mapper C=Core

Eg: If R = 2000 and C = 4

2000*4=8000

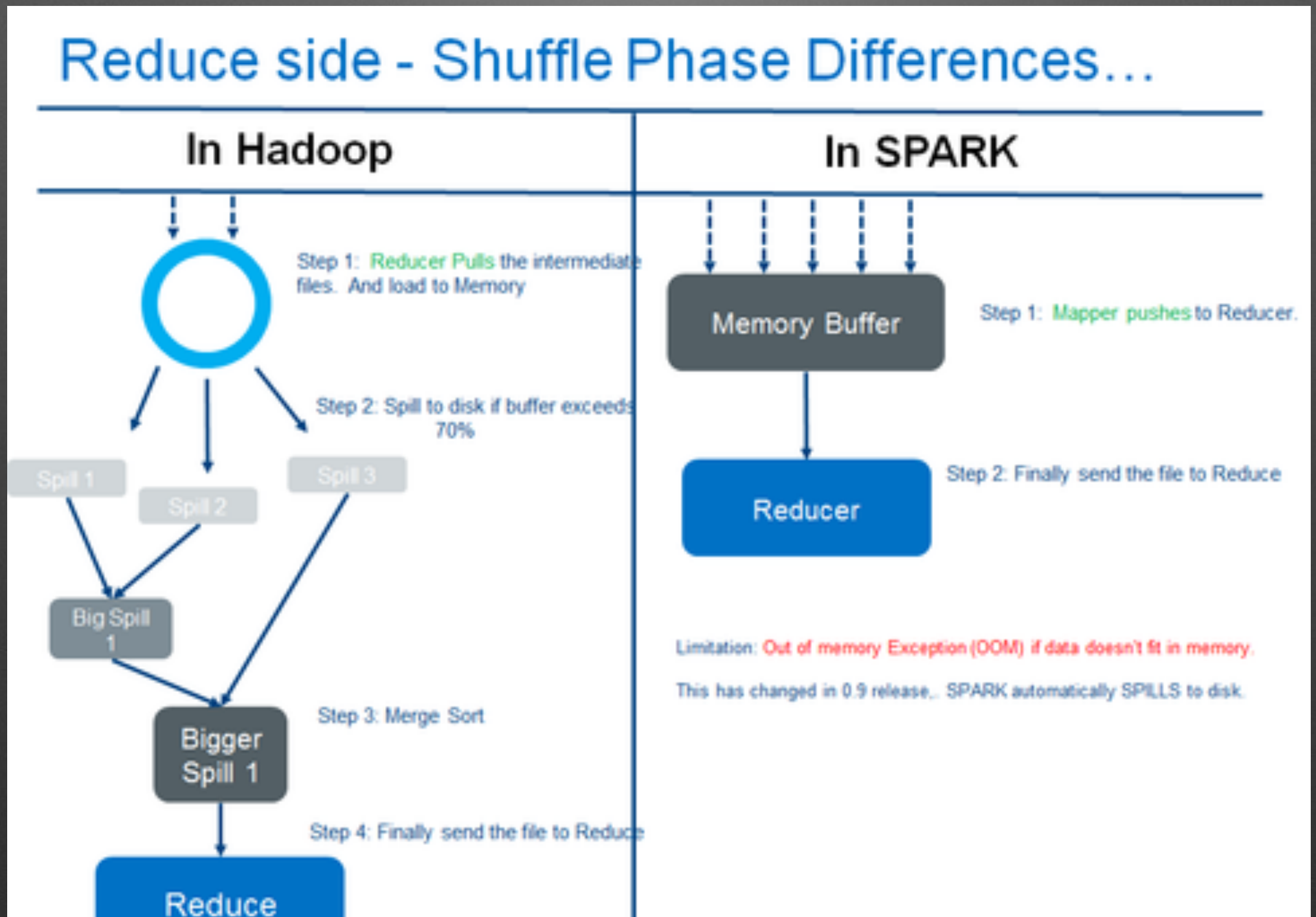
Around 8000 Shuffle files. Huge improvement in performance.

SET:
spark.shuffle.consolidateFiles
To
"true"

**Node1 with 4 Cores**

https://www.quora.com/What-is-the-difference-between-Apache-Spark-and-Apache-Hadoop-Map-Reduce#!n=

# Reduce, vs Hadoop




https://www.quora.com/What-is-the-difference-between-Apache-Spark-and-Apache-Hadoop-Map-Reduce#!n=

# Fault-Tolerant

- Data Replication: 어라?, 더 느리다.
- Check-Point 설정: 어라?! 더욱 느리다.

- Insert Only, No Modify
  - => RDD(Resilient Distributed DataSet) 모델

# RDD

- Immutable
- Distributed
- Lazily evaluated
- Type inferred
- Cacheable

General Data -> RDD 일방향 변환

# RDD Operator

- Transformations
  - Map, Reduce, Join 등 풍부한 명령어로 Data를 보다 자유롭게 컨트롤
  - 수행 플랜(Lineage)만 계획, 실제 연산은 이루어지지 않음
- Actions: Output을 산출하기 위해 실제 연산

- Lazy-Execution에 따른 이득
  - 분산 자원 배치 상황을 고려, 최적의 코스로 실행

# Node Distribution

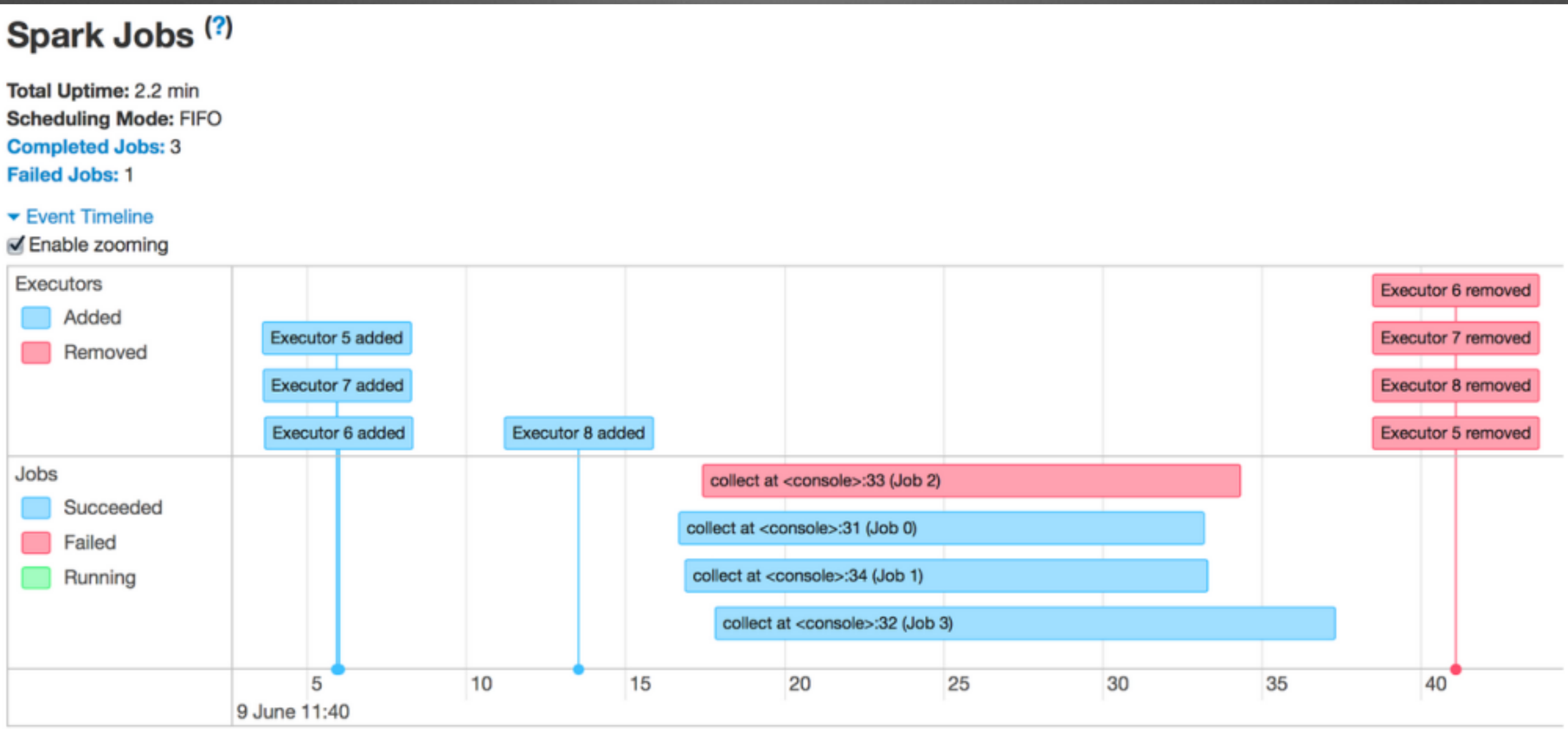
- Wide-Dependency
  - 노드 분산에 의한 네트워크 비용 증대
  - Crash/FailOver 발생 시 복구 비용 증대
- Narrow-Dependency
  - 노드 분산 방지로 네트워크 비용 감소
  - Crash/FailOver 발생 시 복구 비용 감소

물론 이딴걸 몰라서 못하는건 아니다..

# Job Scheduling

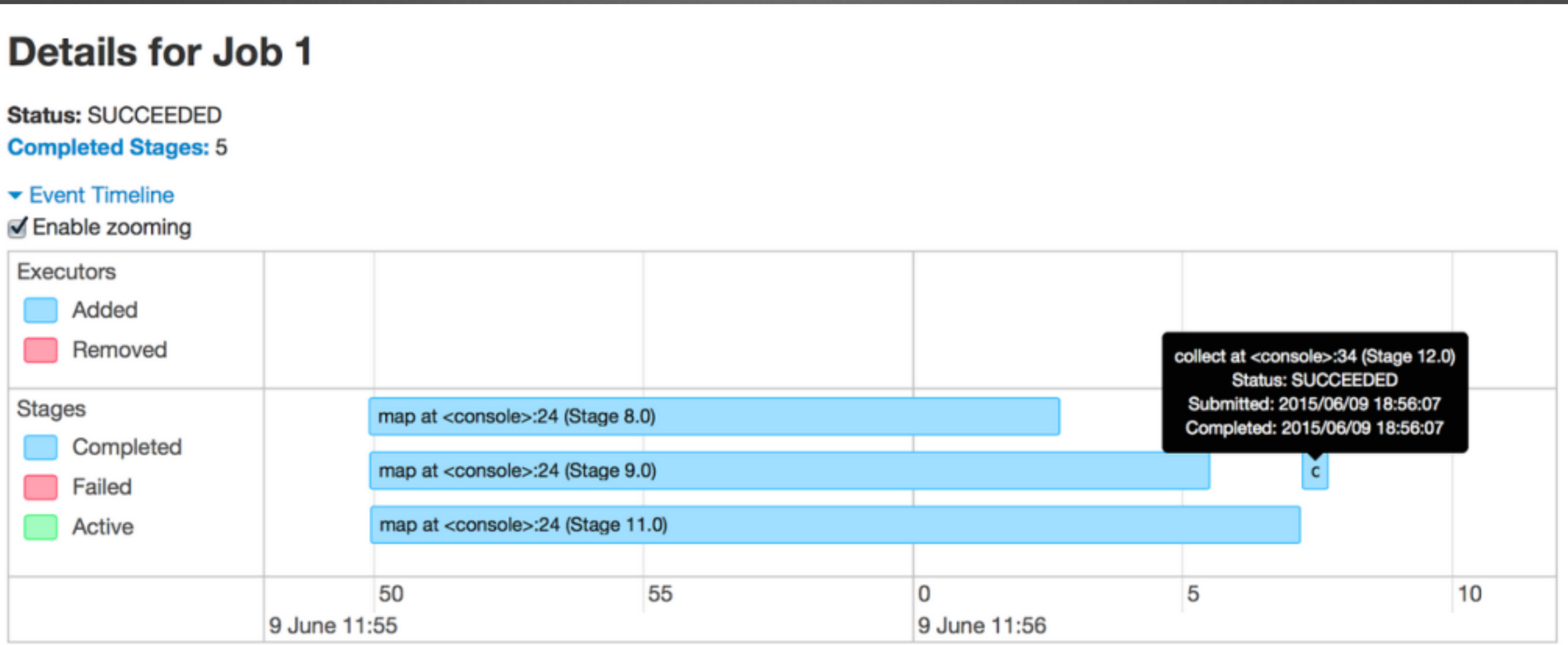
- Directed Acyclic Graph에 의거 실시
- 중복/반복 파티션은 연산 Skip
- 수행 노드는 Locality 고려 선정

# Job Scheduling




https://databricks.com/blog/2015/06/22/understanding-your-spark-application-through-visualization.html

# Job Scheduling




https://databricks.com/blog/2015/06/22/understanding-your-spark-application-through-visualization.html

# Job Scheduling

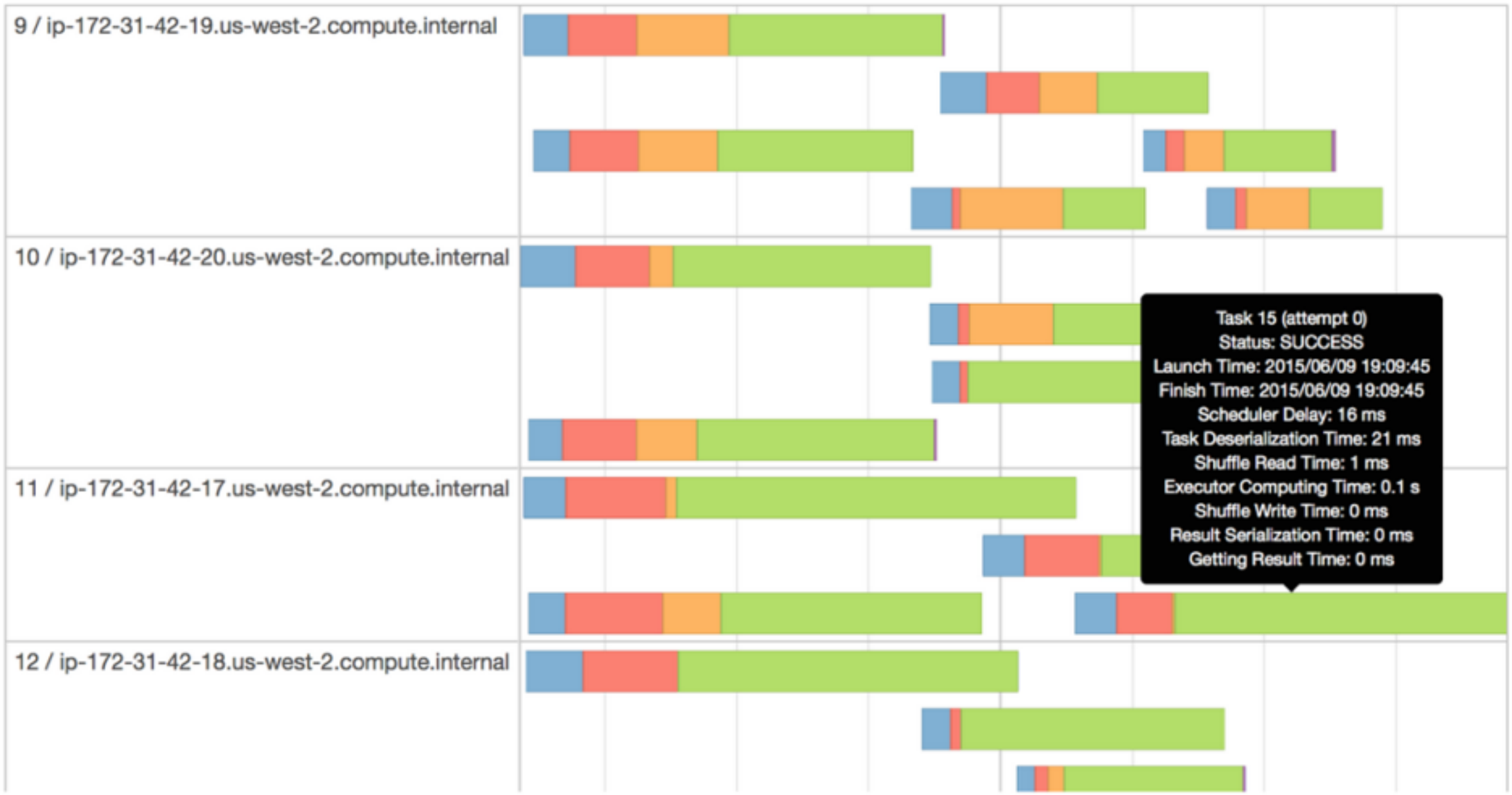
## Details for Stage 11 (Attempt 0)

**Total Time Across All Tasks:** 2 s
**Shuffle Read:** 200.2 KB / 13839

- DAG Visualization
- Show Additional Metrics
- Event Timeline

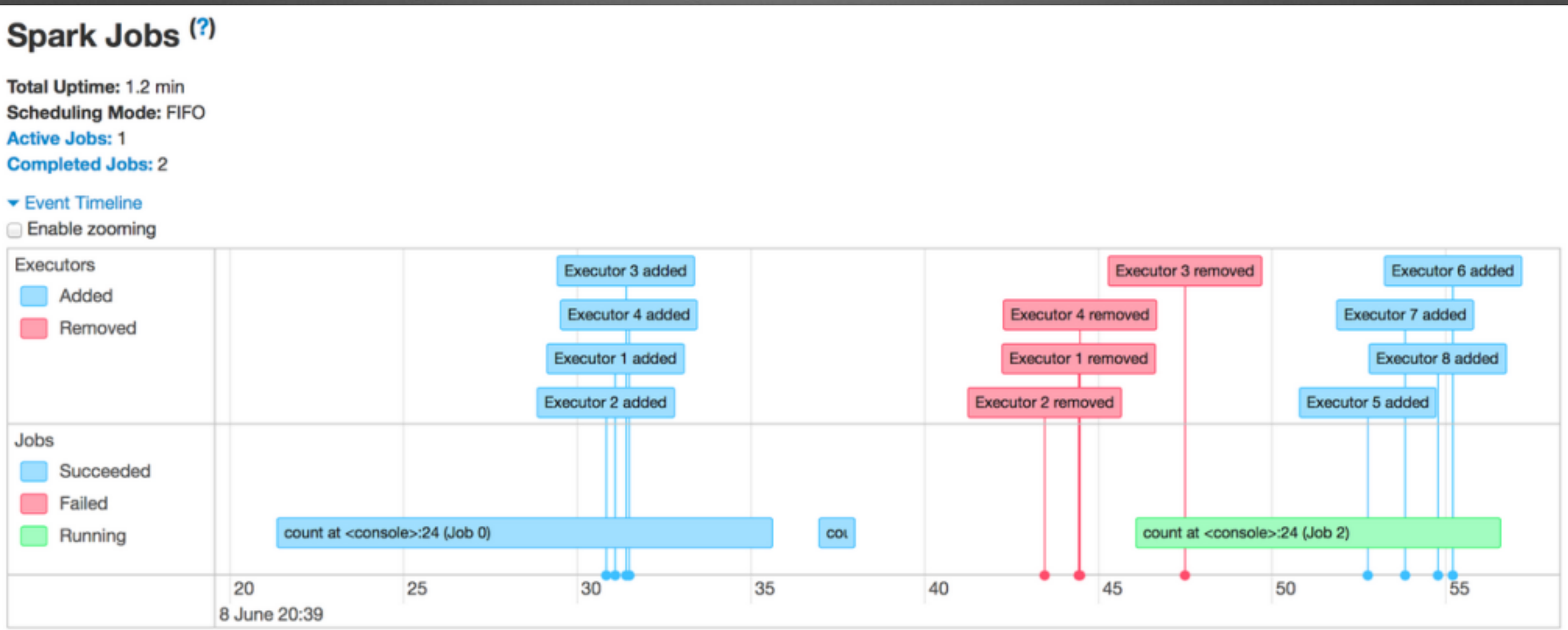
Enable zooming

Scheduler Delay
Task Deserialization Time
Shuffle Read Time
Executor Computing Time
Shuffle Write Time
Result Serialization TIme
Getting Result Time




https://databricks.com/blog/2015/06/22/understanding-your-spark-application-through-visualization.html

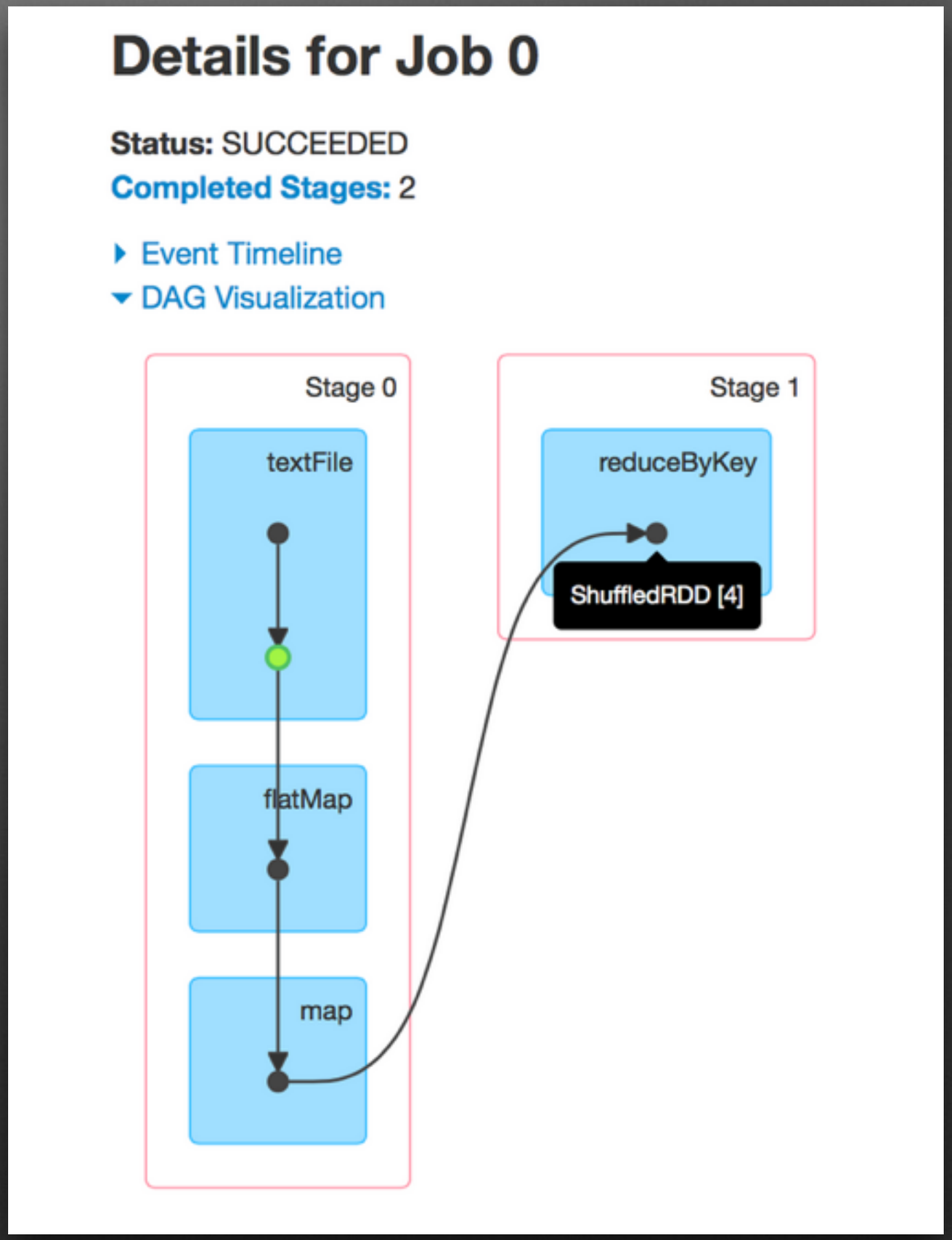
# Job Scheduling




https://databricks.com/blog/2015/06/22/understanding-your-spark-application-through-visualization.html

# DAG
# Direct Acyclic Graph

Sequence on a simple job




https://databricks.com/blog/2015/06/22/understanding-your-spark-application-through-visualization.html

# Exception Handling

- You need more Pylo.. Memories.
  - LRU(Least Recently Used) 순으로 파티션 관리

- Fault Recovery / FailOver
  - 기록된 수행 로그(Lineage)에 따라 Recovery
  - 파티션 자체 파괴시 Secondary Node에서 복구

# Hadoop Word Counting

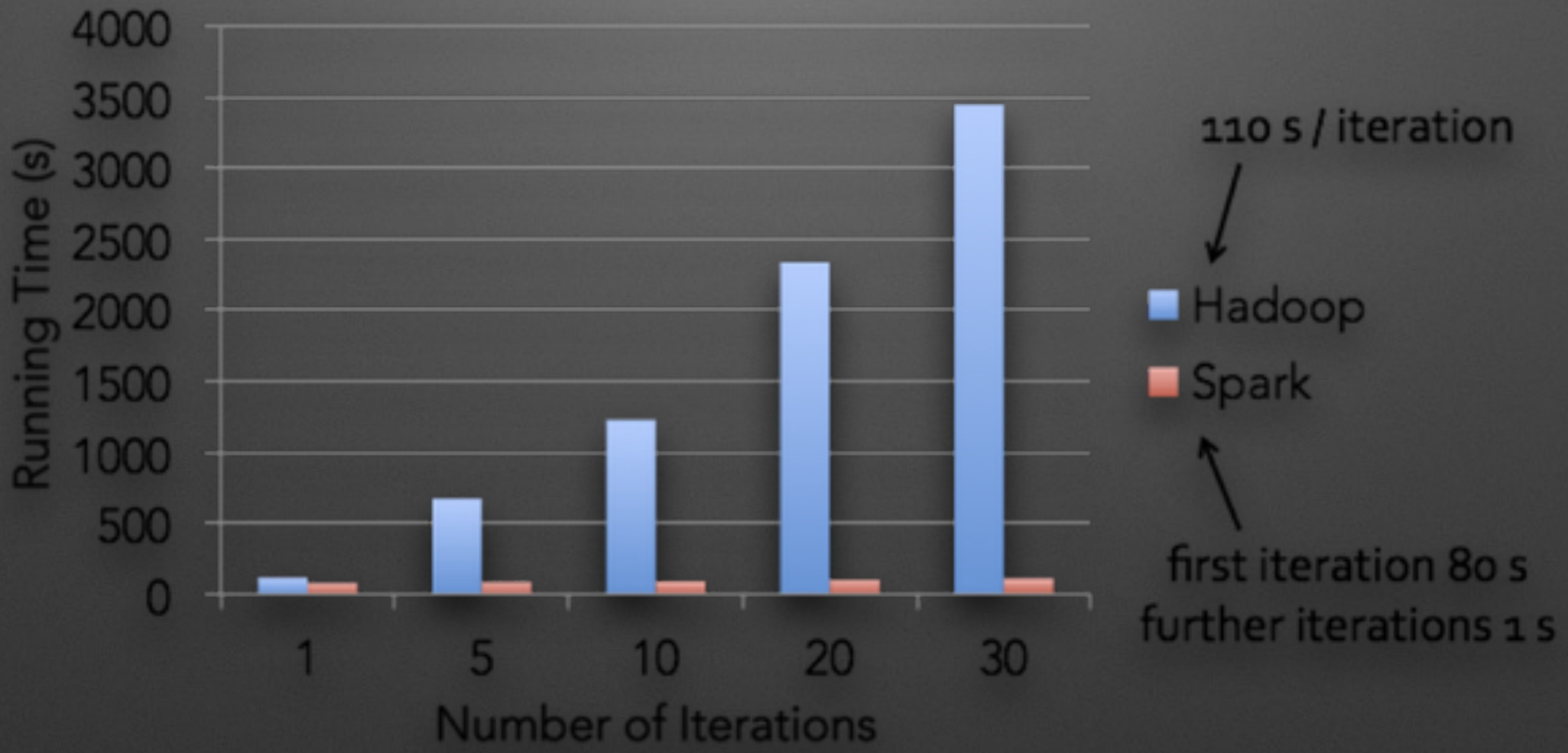
```
public static class WordCountMapClass extends MapReduceBase
  implements Mapper&lt;LongWritable, Text, Text, IntWritable&gt; {
  private final static IntWritable one = new IntWritable(1);
  private Text word = new Text();
  public void map(LongWritable key, Text value,
                  OutputCollector&lt;Text, IntWritable&gt; output,
                  Reporter reporter) throws IOException {
    String line = value.toString();
    StringTokenizer itr = new StringTokenizer(line);
    while (itr.hasMoreTokens()) {
      word.set(itr.nextToken());
      output.collect(word, one);
    }
  }
}
public static class WorkdCountReduce extends MapReduceBase
  implements Reducer&lt;Text, IntWritable, Text, IntWritable&gt; {
  public void reduce(Text key, Iterator values,
                     OutputCollector&lt;Text, IntWritable&gt; output,
                     Reporter reporter) throws IOException {
    int sum = 0;
    while (values.hasNext()) {
      sum += values.next().get();
    }
    output.collect(key, new IntWritable(sum));
  }
}
```

I love Java!

# Spark Word Counting

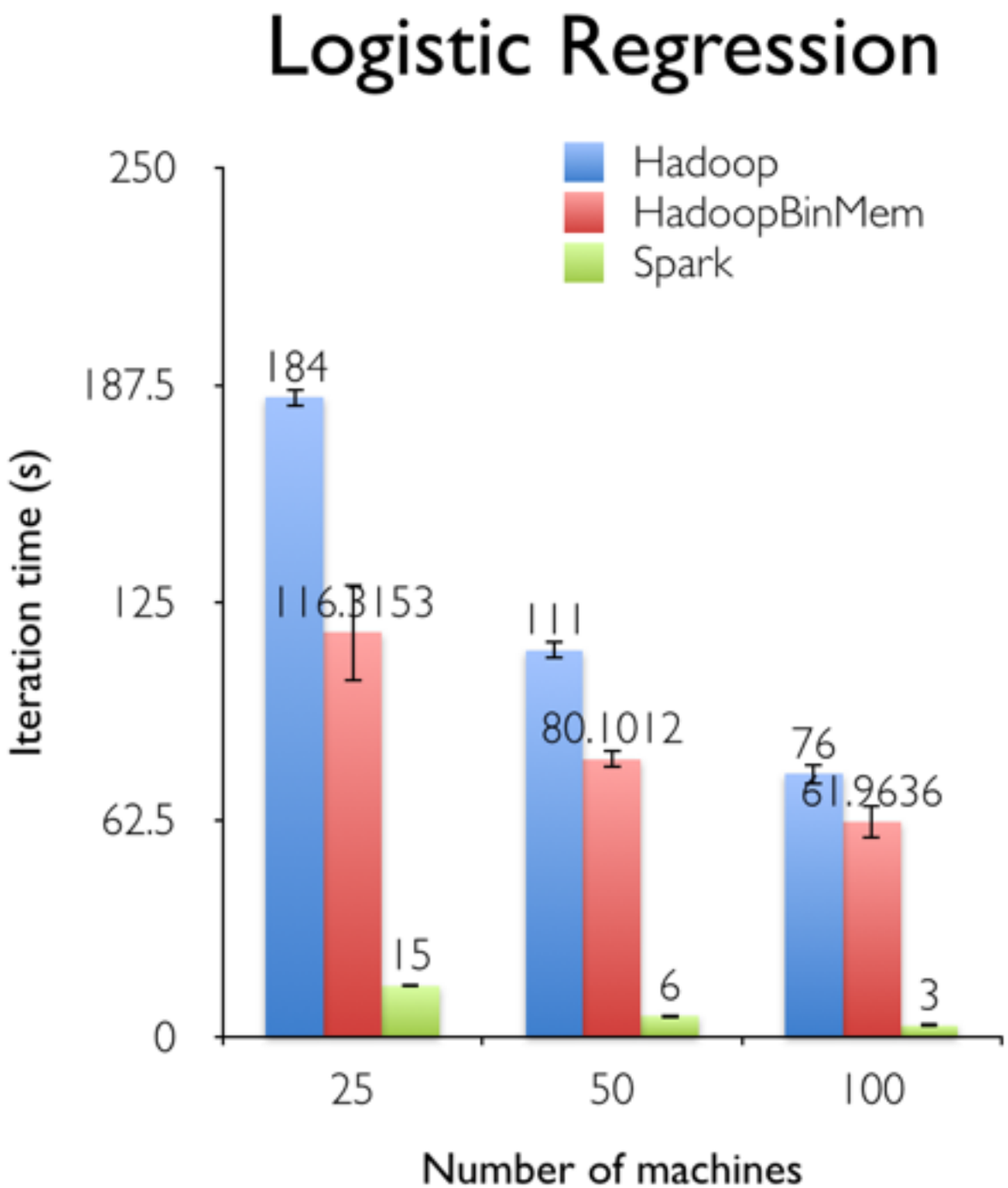
```
if __name__ == "__main__":
    if len(sys.argv) != 2:
        print("Usage: wordcount <file>", file=sys.stderr)
        exit(-1)
    sc = SparkContext(appName="PythonWordCount")
    lines = sc.textFile(sys.argv[1], 1)
    counts = lines.flatMap(lambda x: x.split(' ')) \
                  .map(lambda x: (x, 1)) \
                  .reduceByKey(add)
    output = counts.collect()
    for (word, count) in output:
        print("%s: %i" % (word, count))

    sc.stop()
```

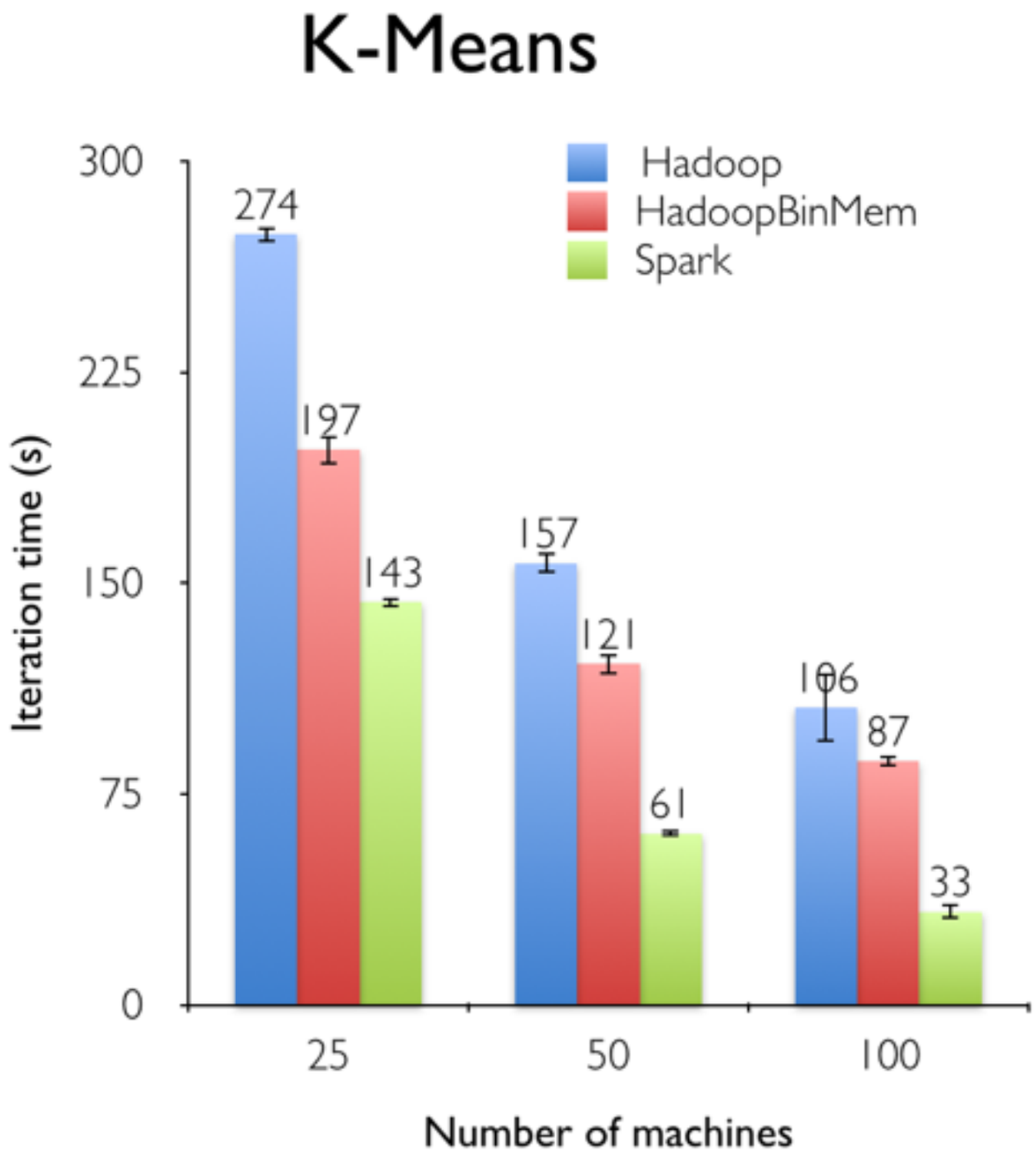
# VS Hadoop




http://blog.cloudera.com/blog/2014/03/apache-spark-a-delight-for-developers/

# VS Hadoop


Logistic Regression
Hadoop
HadoopBinMem
Spark
250
187.5
125
62.5
0
Iteration time (s)
184
116.3153
111
80.1012
76
61.9636
15
6
3
25
50
100
Number of machines


K-Means
Hadoop
HadoopBinMem
Spark
300
225
150
75
0
Iteration time (s)
274
197
143
157
121
61
106
87
33
25
50
100
Number of machines

# Conclusion

# 일단 정말이다!

시스템과 분석 조건에 따라 결과가 다를 수 있는 건 본인의 책임이 아니다

# Exercises

# Environment

- Amazon AWS Account
- Get Ubuntu 14.04 LTS Instance
- MongoDB Install on Ubuntu with apt-get
- JDK Install: sudo apt-get install openjdk-7-jre
- Spark Install on Ubuntu
- Install MongoDB Hadoop Connector with Spark
  - https://github.com/mongodb/mongo-hadoop/archive/r1.4.2.tar.gz

# AWS Ubuntu configure

- sudo apt-get update
- sudo apt-get install language-pack-ko
- sudo apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --recv 7F0CEB10
- echo "deb http://repo.mongodb.org/apt/ubuntu trusty/mongodb-org/3.0 multiverse" | sudo tee /etc/apt/sources.list.d/mongodb-org-3.0.list
- sudo apt-get update
- sudo apt-get install -y mongodb-org

# MongoDB

# Master/Slave

# > mongod --help

```
Master/slave options (old; use replica sets instead):
  --master              master mode
  --slave               slave mode
  --source arg          when slave: specify master as <server:port>
  --only arg            when slave: specify a single database to replicate
  --slavedelay arg      specify delay (in seconds) to be used when applying  master
ops to slave
  --autoresync          automatically resync if slave data is stale

Replica set options:
  --replSet arg           arg is <setname>[/<optionalseedhostlist>]
  --replIndexPrefetch arg specify index prefetching behavior (if secondary)

Sharding options:
  --configsvr           declare this is a config db of a cluster; default port 27019;
default dir /data/configdb
  --shardsvr            declare this is a shard db of a cluster; default port 27018
```

# Master 구성

- mongod --dbpath {master_path} --master --port {port}

- mongo --port {port}
  > show dbs
  local  0.328125GB

  > db.printReplicationInfo()
  configured oplog size:  192MB
  log length start to end: 317secs (0.09hrs)
  oplog first event time:  Sat Jan 27 2016 11:50:16 GMT+0900 (KST)
  oplog last event time:  Sat Jan 27 2016 11:55:33 GMT+0900 (KST)
  now:  Sat Jan 27 2016 11:55:36 GMT+0900 (KST)

# Master 구성

- > db.printSlaveReplicationInfo()
  local.sources is empty; is this db a --slave?
- > db.printShardingStatus()
  printShardingStatus: this db does not have sharding enabled. be sure you are connecting to a mongos from the shell and not to a mongod.

# Slave 구성

- mongod --dbpath {slave_path} --slave --port {port} --source {master_ip:maseter_port}

```
Sat Jan 27 12:04:55.853 [initandlisten] MongoDB starting : pid=70927 port=48000 dbpath=mongodb_2.4.5/slave slave=1 64-bit host=nulpulum-mac-13-retina.local
Sat Jan 27 12:04:55.853 [initandlisten] options: { dbpath: "/mongodb_2.4.5/slave", port: 48000, slave: true, source: "localhost:38000" }
Sat Jan 27 12:04:56.891 [replslave] build index done.  scanned 0 total records. 0 secs
```

# Master-Slave 확인

- > db.printSlaveReplicationInfo()

  =Slave=
  source:  localhost:38000
  syncedTo: Sat Jan 27 2016 12:09:53 GMT+0900 (KST) = 74 secs ago (0.02hrs)
  =Master=
  local.sources is empty; is this db a —slave?

- On Master
  > use SomeDB
  > db.data.save({name: ‘jungwon’, age: undefined});

- On Slave
  > use SomeDB
  > db.data.find();
  {_id: ‘51f33a81dbed34cf65d102d0’, name: ‘jungwon’, age: undefined}

# 3-Way Replica Set

# 3 Instances

- 3개의 동일 RepI 이름을 가진 mongod insatance 생성
- mongod --replSet {set_name} --port  {each_port}  --dbpath {each_path}

```
Sat Jan 27 14:11:58.007 [initandlisten] MongoDB starting :
pid=71010 port=20000 dbpath=/mongodb_2.4.5/db1 64-bit
host=nulpulum-mac-13-retina.local
Sat Jan 27 14:11:58.299 [websvr] admin web console waiting for
connections on port 21000
Sat Jan 27 14:11:58.300 [initandlisten] waiting for connections on
port 20000
Sat Jan 27 14:12:08.302 [rsStart] replSet can't get
local.system.replset config from self or any seed (EMPTYCONFIG)
```

# Configuration

- mongo {db_ip}:{db_port}

- 동일한 이름 하에 3개의 멤버를 가지는 Repl Set config 생성
  > var config={_id:’repl_name’, members:[{_id:0, host:'localhost:20000'}, {_id:1, host:'localhost:30000'}, {_id:2, host:'localhost:40000'}] };

- 해당 config를 이용한 rs 셋팅
  rs.initiate(config);
  ```
  {
      "info" : "Config now saved locally.  Should come online in about a minute.",
      "ok" : 1
  }
  ```

- rs.slaveOk()

# > rs.help()

| | |
|---|---|
| rs.status() | { replSetGetStatus : 1 } checks repl set status |
| rs.initiate() | { replSetInitiate : null } initiates set with default settings |
| rs.initiate(cfg) | { replSetInitiate : cfg } initiates set with configuration cfg |
| rs.conf() | get the current configuration object from local.system.replset |
| rs.reconfig(cfg) | updates the configuration of a running replica set with cfg |
| rs.add(hostportstr) | add a new member to the set with default attributes |
| rs.add(membercfgobj) | add a new member to the set with extra attributes |
| rs.addArb(hostportstr) | add a new member which is arbiterOnly:true |
| rs.stepDown([secs]) | step down as primary (momentarily) (disconnects) |
| rs.syncFrom(hostportstr) | make a secondary to sync from the given member |
| rs.freeze(secs) | make a node ineligible to become primary for the time specified |
| rs.remove(hostportstr) | remove a host from the replica set (disconnects) |
| rs.slaveOk() | shorthand for db.getMongo().setSlaveOk() |
| db.isMaster() | check who is primary |
| db.printReplicationInfo() | check oplog size and time range |

# Key Point

- Insert는 Primary에서만 가능
- Secondary의 read 시 rs.slaveOk() 필요
- Primary connection fail 시 auto election

# N-Way Shard

# n Instances

- mongod --shardsvr —dbpath {each_path} --port {each_port}

  Sat Jan 27 15:15:40.854 [initandlisten] MongoDB starting : pid=71105 port=10000 dbpath=/mongodb_2.4.5/db11 64-bit host=nulpulum-mac-13-retina.local
  Sat Jan 27 15:15:41.141 [initandlisten] command local.$cmd command: { create: "startup_log", size: 10485760, capped: true } ntoreturn:1 keyUpdates:0  reslen:37 271ms
  Sat Jan 27 15:15:41.141 [websvr] admin web console waiting for connections on port 11000
  Sat Jan 27 15:15:41.142 [initandlisten] waiting for connections on port 10000

# Configure Config Server

- mongod --configsvr --dbpath {config_path} --port {config_port}

  Sat Jan 27 15:22:12.404 [initandlisten] MongoDB starting : pid=71141 port=40000 dbpath=/mongodb_2.4.5/config1 master=1 64-bit host=nulpulum-mac-13-retina.local
  Sat Jan 27 15:22:12.544 [initandlisten] creating replication oplog of size: 5MB...
  Sat Jan 27 15:22:12.547 [initandlisten] ******
  Sat Jan 27 15:22:12.547 [websvr] admin web console waiting for connections on port 41000
  Sat Jan 27 15:22:12.547 [initandlisten] waiting for connections on port 40000

# > mongos --help

- Sharding options:

--configdb arg  1 or 3 comma separated config servers

--localThreshold arg  ping time (in ms) for a node to be considered local (default 15ms)

--test  just run unit tests

--upgrade  upgrade meta data version

--chunkSize arg  maximum amount of data per chunk (기본 : 64kbytes)

--ipv6  enable IPv6 support (disabled by default)

--jsonp  allow JSONP access via http (has security implications)

--noscripting  disable scripting engine

# Mongo Server

- mongos --configdb {cfg_ip:cfg_port} --chunkSize 1 --port {server_port}
- mongo —port {mongos_port}
- > use admin
- > db.runCommand({addShard: ‘{shard_ip:shard:port}’});
  { "shardAdded" : "shard0000", "ok" : 1 }
- > db.runCommand({ enablesharding: ‘db_name' });
- db.runCommand({ shardcollection: ‘db_name.collection_name’, key:{_id:1} });

# Shard Test

- On mongos
- > use {db_name}
- for(var i=0; i < 10000000 ; i++)
  { db.db_name.save({ age: i, name:i+”, address: i+’
  street’}); };

# Spark with MongoDB

# Environment

- Install Spark
  - http://www.apache.org/dyn/closer.lua/spark/spark-1.6.0/spark-1.6.0.tgz
- Install MongoDB
- Install JAVA: sudo apt-get install default-jdk
- Install MongoDB Hadoop Connector
- Download Sample Data

# Sort

```
from __future__ import print_function
import sys
from pyspark import SparkContext
if __name__ == "__main__":
    if len(sys.argv) != 2:
        print("Usage: sort <file>", file=sys.stderr)
        exit(-1)
    sc = SparkContext(appName="PythonSort")
    lines = sc.textFile(sys.argv[1], 1)
    sortedCount = lines.flatMap(lambda x: x.split(' ')) \
        .map(lambda x: (int(x), 1)) \
        .sortByKey(lambda x: x)
    output = sortedCount.collect()
    for (num, unitcount) in output:
        print(num)
    sc.stop()

# spark-submit sort.py {target_file}
```

# WordCount

```
from __future__ import print_function
import sys
from operator import add
from pyspark import SparkContext

if __name__ == "__main__":
    if len(sys.argv) != 2:
        print("Usage: wordcount <file>", file=sys.stderr)
        exit(-1)
    sc = SparkContext(appName="PythonWordCount")
    lines = sc.textFile(sys.argv[1], 1)
    counts = lines.flatMap(lambda x: x.split(' ')) \
                  .map(lambda x: (x, 1)) \
                  .reduceByKey(add)
    output = counts.collect()
    for (word, count) in output:
        print("%s: %i" % (word, count))

    sc.stop()

# spark-submit wordcount.py {target_file}
```

# Configure MongoDB

- Start MongoDB
  mongod -f /etc/mongod.conf

- Load Sample Data
  mongoimport mstf.csv --type csv --headerline -d marketdata -c minibars —port {db_port}

- > use marketdata

- > db.minbars.findOne()

# Test with python

- Data를 Spark RDD format으로 변환

```
config = {"mongo.input.uri": "mongodb://localhost:27017/
marketdata.minbars"}

inputFormatClassName = "com.mongodb.hadoop.MongoInputFormat"

keyClassName = "org.apache.hadoop.io.Text"

valueClassName = "org.apache.hadoop.io.MapWritable"

minBarRawRDD = sc.newAPIHadoopRDD(inputFormatClassName,
keyClassName, valueClassName, None, None, config)
```

# Test with python

- output을 MongoDB에 저장

config["mongo.output.uri"] = "mongodb://localhost:27017/marketdata.fiveminutebars"

outputFormatClassName = "com.mongodb.hadoop.MongoOutputFormat"

- Raw 데이터 치환

minBarRDD = minBarRawRDD.values()

# Test with python

- 시간순 정렬 & 5분 단위 group

```
import calendar, time, math

dateFormatString = '%Y-%m-%d %H:%M’

groupedBars = minBarRDD.sortBy(lambda doc:
str(doc["Timestamp"])).groupBy(lambda doc (doc["Symbol"],
math.floor(calendar.timegm(time.strptime(doc["Timestamp"],
dateFormatString)) / (5*60))))
```

# Test with python

```
def ohlc(grouping):
    low = sys.maxint
    high = -sys.maxint
    i = 0
    groupKey = grouping[0]
    group = grouping[1]
    for doc in group:
    if i == 0:
        openTime = doc["Timestamp"]
        openPrice = doc[“Open”]
    if doc["Low"] < low:
      low = doc["Low"]
```

# Test with python

```
if doc["High"] > high:
        high = doc["High"]

i = i + 1
# take close of last bar
if i == len(group):
        close = doc["Close"]
        outputDoc = {"Symbol": groupKey[0],
    "Timestamp": openTime,
    "Open": openPrice,
        "High": high,
        "Low": low,
        "Close": close}
    return (None, outputDoc)

resultRDD = groupedBars.map(ohlc)

resultRDD.saveAsNewAPIHadoopFile("file:///placeholder",    //MongoDB에 output 저장
outputFormatClassName, None, None, None, None, config)
```

https://github.com/nicejwjin/MongoDB-Spark

# 감사합니다

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