# Log Monitoring Architecture

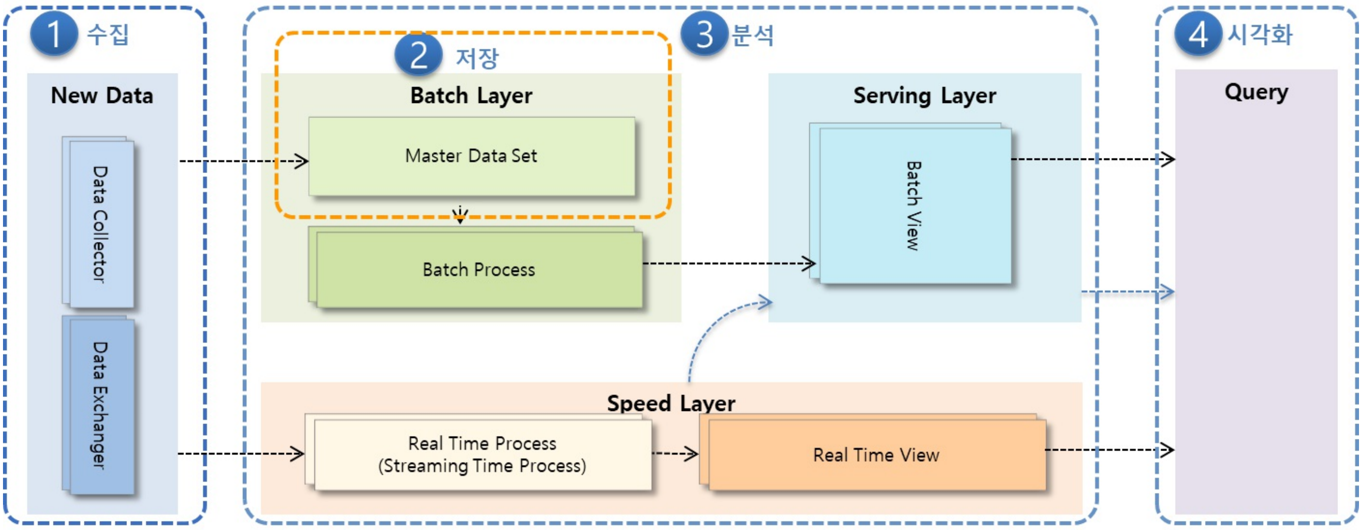
## 목차



## 모니터링 아키텍처 및 요소기술

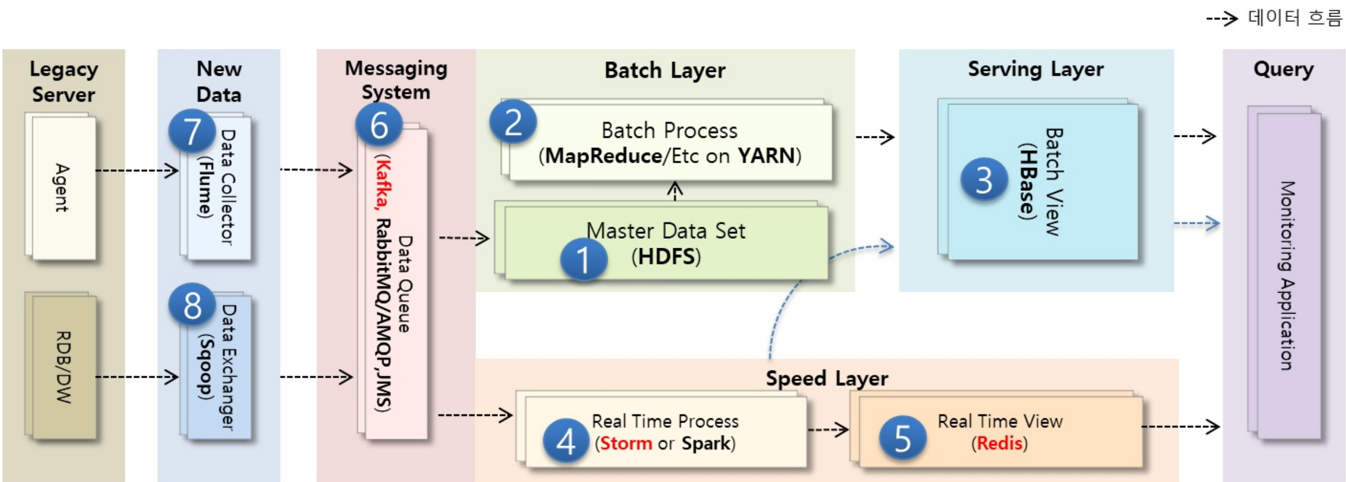
## Lambda Architecture

실시간 분석을 지원하는 빅데이터 아키텍처

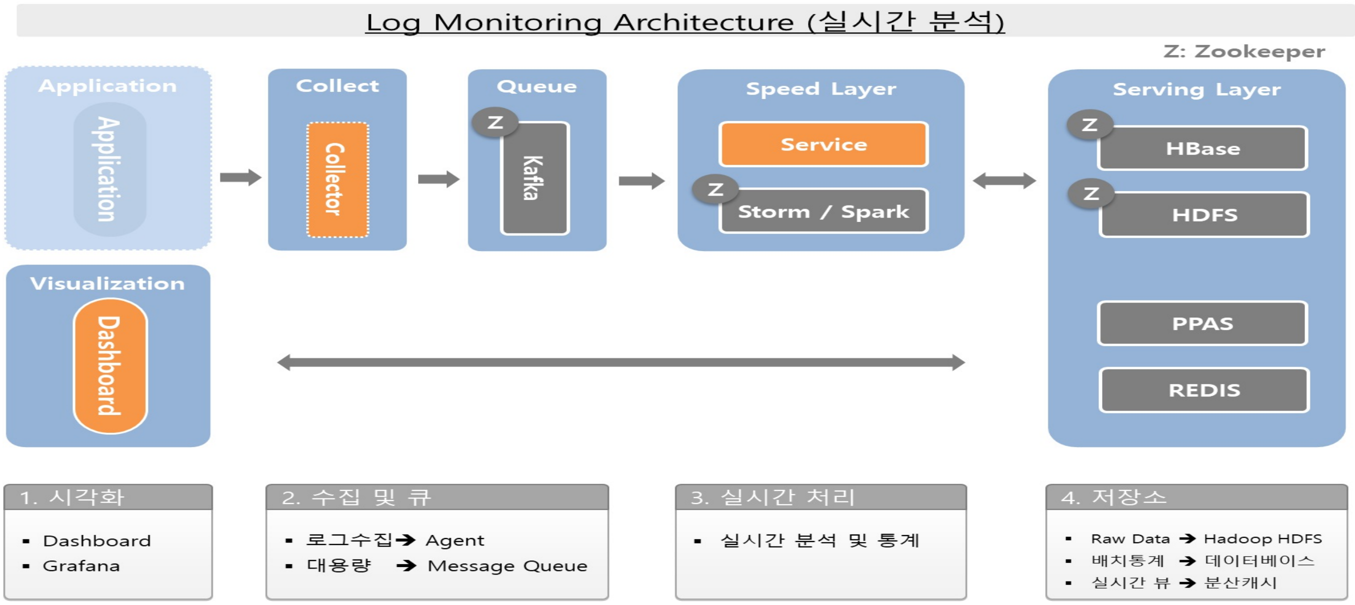



참고: http://lambda-architecture.net/ Lambda Architecture by Nathan Marz

람다 아키텍처에 대한 솔루션 매핑 사례



# Monitoring Architecture(Reference)




# Tech Stack

1. Distributed Platform: Hadoop
2. Data Store: **HBase**
3. Distribute Codinator: Zookeeper
4. Realtime Analysis: **Storm** or Spark
5. Visualization: Grafana
6. TSDB: InfluxDB
7. Collect: Telegraf
8. Message Queue: **Kafka**
9. In Memory Data Grid: Redis

## Other Hadoop-related projects at Apache include:

- Ambari
  - A web-based tool for provisioning, managing, and monitoring Apache Hadoop clusters which includes support for Hadoop HDFS, Hadoop MapReduce, Hive, HCatalog, HBase, ZooKeeper, Oozie, Pig and Sqoop. Ambari also provides a dashboard for viewing cluster health such as heatmaps and ability to view MapReduce, Pig and Hive applications visually alongwith features to diagnose their performance characteristics in a user-friendly manner.
- Avro
  - A data serialization system
  - cf. **Thrift**, Protocol Buffers
- Hive
  - A data warehouse infrastructure that provides data summarization and ad hoc querying.
- Pig
  - A high-level data-flow language and execution framework for parallel computation.
- Spark
  - A fast and general compute engine for Hadoop data. Spark provides a simple and expressive

programming model that supports a wide range of applications, including ETL, machine learning, stream processing, and graph computation.

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# 하둡 및 HBase를 이용한 대용량 테이블 설계

## 2.1 Hadoop

> The Apache Hadoop software library is a framework that allows for the distributed processing of large data sets across clusters of computers using simple programming models.

- reliable, scalable, distributed computing

### HDFS(Hadoop Distributed File System)

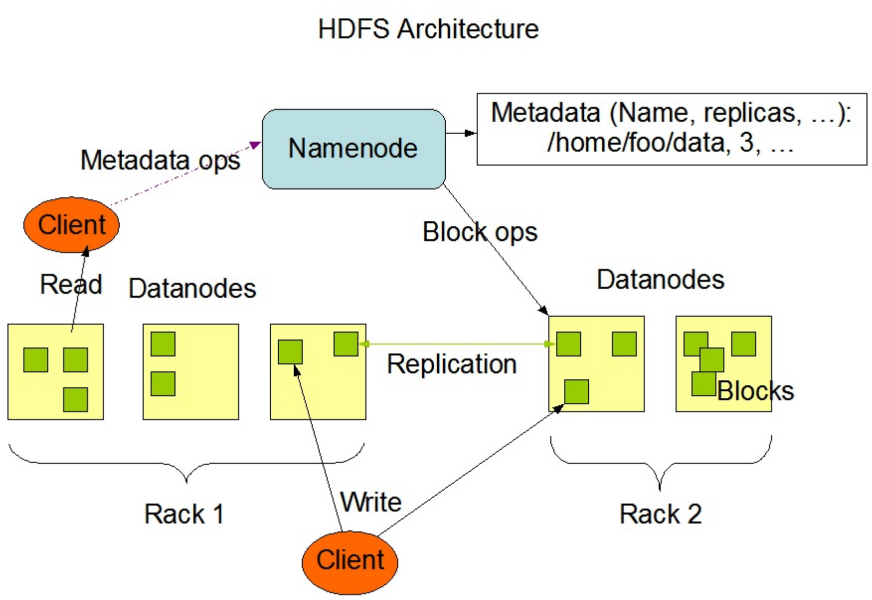
> The Hadoop Distributed File System (HDFS) is a distributed file system designed to run on commodity hardware.

**Assumptions and Goals**

- Hardware Failure
- Streaming Data Access
    - Write Once, Read Any Number Of Times, But Don't Try To Change The Contents Of The File.
    - Throughput > Latency
- Large Data Sets
- Simple Coherency Model
- “Moving Computation is Cheaper than Moving Data”
- Potability Across Heterogeneous Hardware and Software Platforms

**HDFS Architecture**

Master-Slave architecture



**NameNode**

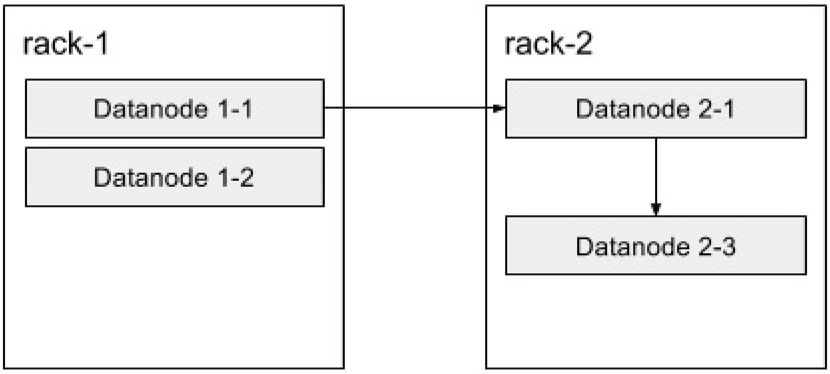
- 파일 시스템의 네임스페이스를 관리
- 클라이언트의 파일 접근을 관리
- 파일 이름 변경, 파일과 디렉토리의 오픈/클로즈와 같은 파일 시스템 작업을 실행

**DataNode**

- 클라이언트의 요청을 읽어서 파일에 읽기/쓰기 작업
- 블럭의 생성, 삭제, 복제와 같은 작업을 수행

**Block**

- 여러 데이터 노드에 작은 파일로 나뉜다음 분산되어 저장
- 블럭의 기본크기는 64MB, HDFS 설정에 따라서 바꿀 수 있음
- 블럭을 보관할 노드의 선택
  - 첫번째 복제는 원본과 같은 랙에 있는 노드를 선택
  - 두번째와 세번째는 다른 랙에 보관




**Operations**

| **Action** | **Command** |
|---|---|
| Create a directory named /foodir | bin/hadoop dfs -mkdir /foodir |
| Remove a directory named /foodir | bin/hadoop fs -rm -R /foodir |
| View the contents of a file named /foodir/myfile.txt | bin/hadoop dfs -cat /foodir/myfile.txt |

## Hadoop 기본 포트

| 파라미터 | 기본 값 | 용도 | 설정 파일 |
|---|---|---|---|
| dfs.secondary.http.address | 50090 | SecondaryNameNode 웹 서버 주소 및 포트 | hdfs-site.xml |
| dfs.datanode.address | 50010 | | |

| | | | |
|---|---|---|---|
| | | DataNode 주소 및 포트 | hdfs-site.xml |
| dfs.datanode.http.address | 50075 | DataNode 웹 서버 용 주소 및 포트 | hdfs-site.xml |
| dfs.datanode.ipc.address | 50020 | DataNode ipc 서버용 주소 및 포트 | hdfs-site.xml |
| dfs.http.address | 50070 | NameNode 웹 어드민용 주소 및 포트 | hdfs-site.xml |
| mapred.job.tracker.http.address | 50030 | JobTracker 웹 서버용 주소 및 포트 | mapred-site.xml |
| mapred.task.tracker.http.address | 50060 | TaskTracker 웹 서버용 웹 주소 및 포트 | mapred-site.xml |

## Apache Hadoop API

### pom.xml

```
<dependency>
  <groupId>org.apache.hadoop</groupId>
  <artifactId>hadoop-client</artifactId>
  <version>2.7.1</version>
</dependency>
```

### HDFSClient.java

```
System.setProperty("HADOOP_USER_NAME", "vagrant");
UserGroupInformation ugi = UserGroupInformation.createRemoteUser("vagrant");

Configuration conf = new Configuration();
conf.set("fs.default.name", "hdfs://hadoop01:9000");

FileSystem dfs = FileSystem.get(conf);

System.out.println("Home Path : " + dfs.getHomeDirectory());
System.out.println("Work Path : " + dfs.getWorkingDirectory());

Path filenamePath = new Path("/tmp/hello.txt");
System.out.println("File Exists : " + dfs.exists(filenamePath));

if (dfs.exists(filenamePath)) {
  dfs.delete(filenamePath, true);
}

FSDataOutputStream out = dfs.create(filenamePath);
out.writeUTF("Hello, world!\n");
out.close();

FSDataInputStream in = dfs.open(filenamePath);
```

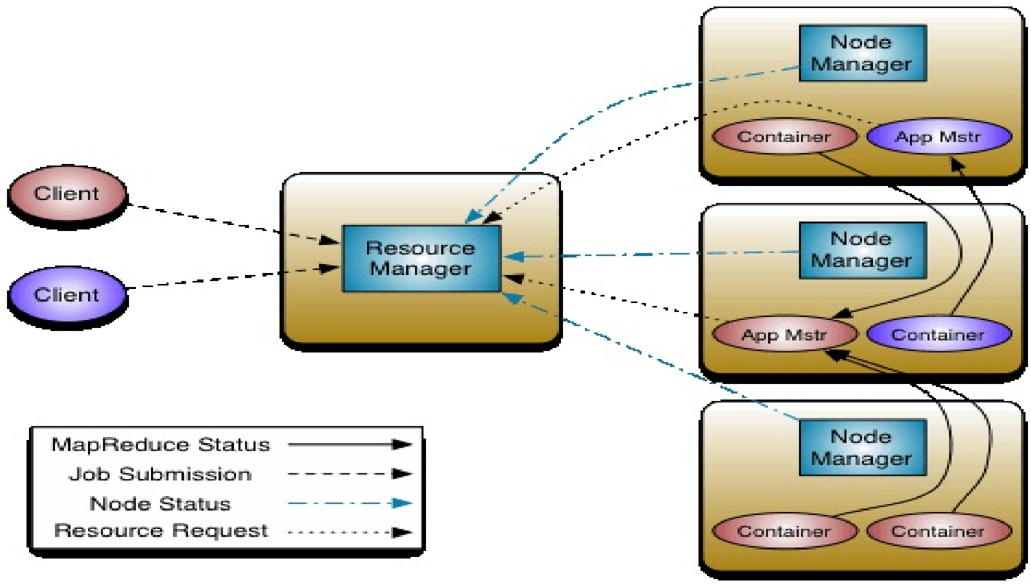
```
    String messageIn = in.readUTF();
    System.out.print(messageIn);

    in.close();
    dfs.close();
```

실행결과

```
[vagrant@hadoop03 ~]$ hadoop fs -ls /tmp
Found 1 items
-rw-r--r--   3 vagrant supergroup         16 2018-01-24 19:47 /tmp/hello.txt
[vagrant@hadoop03 ~]$ hadoop fs -cat /tmp/hello.txt
 Hello, world!
```

Map & Reduce

**Apache Hadoop NextGen MapReduce (YARN)**




Functional Programming

Map

- Data Processing

Reduce

- Merge

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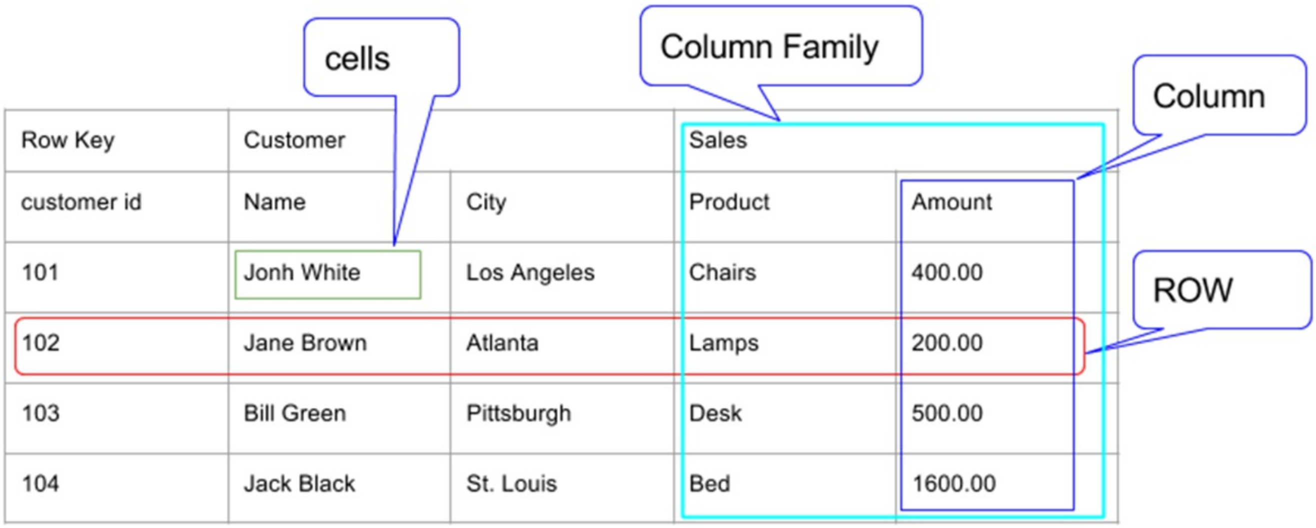
## 2.2 HBase

> Apache HBase™ is the Hadoop database, a distributed, scalable, big data store.

- NoSQL
- Schemaless
- 가용성과 확장성
    - Region 서버만 추가하여 확장성 및 가용성 확보가 용이
    - 단, 특정 Region 서버에 부하가 집중되면 성능저하가 발생 -> 로우키 설계가 중요
- CAP: "분산 시스템에서는 다음의 3개 속성을 모두 가지는 것이 불가능하다"
    - Consistency (V)
    - **Availability**
    - Partitions Tolerance (V)
- Apache Phoenix: Add SQL Layer

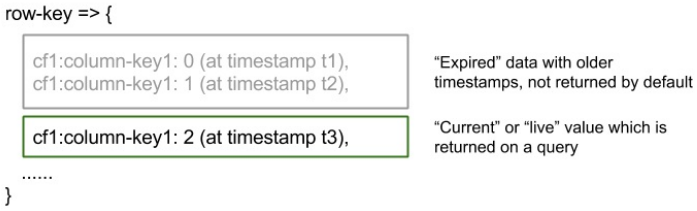
## Column Family




| Row Key | Customer | | Sales | |
|---|---|---|---|---|
| customer id | Name | City | Product | Amount |
| 101 | Jonh White | Los Angeles | Chairs | 400.00 |
| 102 | Jane Brown | Atlanta | Lamps | 200.00 |
| 103 | Bill Green | Pittsburgh | Desk | 500.00 |
| 104 | Jack Black | St. Louis | Bed | 1600.00 |

1. 이 테이블은 Customer와 Sales 두 개의 컬럼 패밀리를 가지고 있다.
2. Customer 컬럼 패밀리는 Name과 City 두 개의 컬럼을 가지고 있다.
3. Sales 컬럼 패밀리는 Product와 Amount 두 개의 컬럼을 가지고 있다.
4. Row는 Row Key, Customer CF, Sales CF로 구성된다.

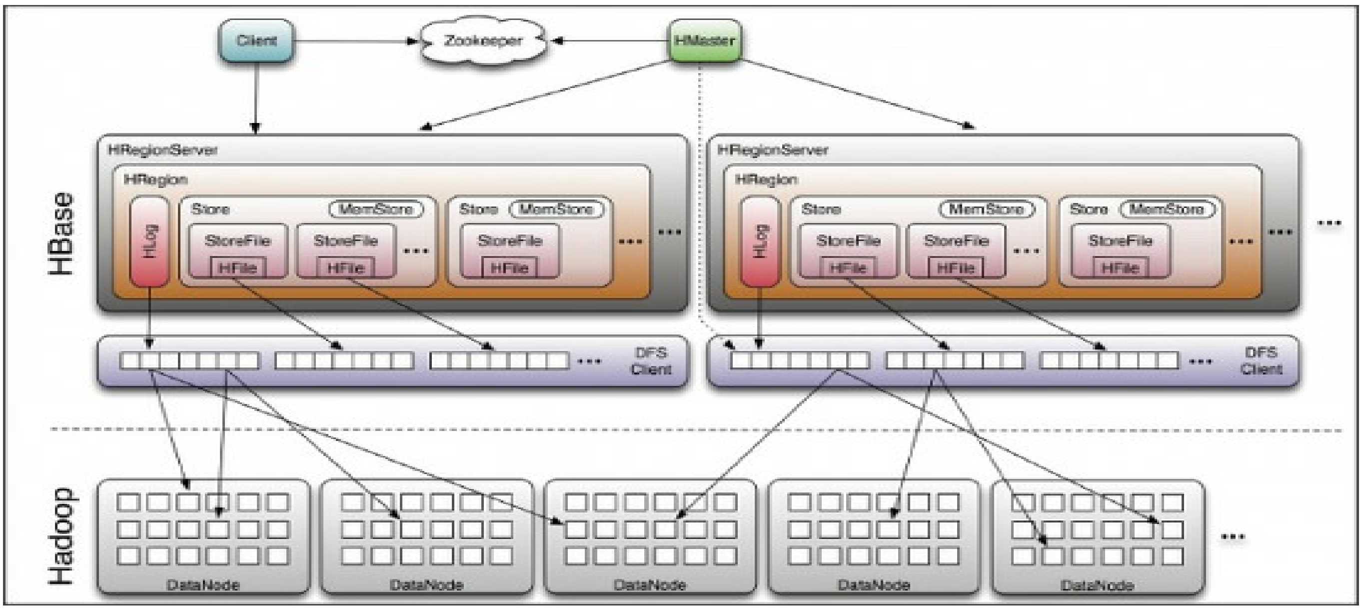
## 특징




| Row Key | Timestamp | Customer | | Sales | |
|---|---|---|---|---|---|
| customer id | | Name | City | Product | Amount |
| 101 | T1 | Suresh | Hyderabad | | 300.00 |
| 101 | T2 | Suresh Reddy | | Books | |
| 102 | T1 | Lavya Gavshinde | Indore | Fan | 600 |
| 102 | T2 | | Bhopal | | |
| 102 | T3 | Deepesh | Delhi | Bike | 32000 |

1. Sparse: HBase는 sparse matrix(희소행렬)방식으로 데이터를 저장 할 수 있다. 예컨데 굳이 모든 필드에 값을 채울 필요가 없다는 얘기다.
2. Column Oriented: RDBMS는 row 단위로 데이터를 저장한다. 하지만 HBase는 Sparse하기 때문에, 컬럼 단위로 데이터를 읽고 쓸 수 있다.
3. Distributed: 테이블은 수백만개의 Row와 컬럼들로 구성된다. 이들 컬럼들은 쉽게 분산 할 수 있다.
4. Versioned: 위 테이블은 Customer ID를 Row key로 사용하고 있다. 당연하지만 고객은 하나 이상의 물건을 구매할 수 있기 때문에 하나의 row key에 여러 개의 row를 저장 할 수 있다. 이 경우 Timestamp가 버전이 되며, 질의를 할 경우 가장 최근 timestamp의 row를 읽어 온다.
5. Non-relational: 관계형 데이터베이스의 ACID 속성을 따르지 않는다.

## Architecture

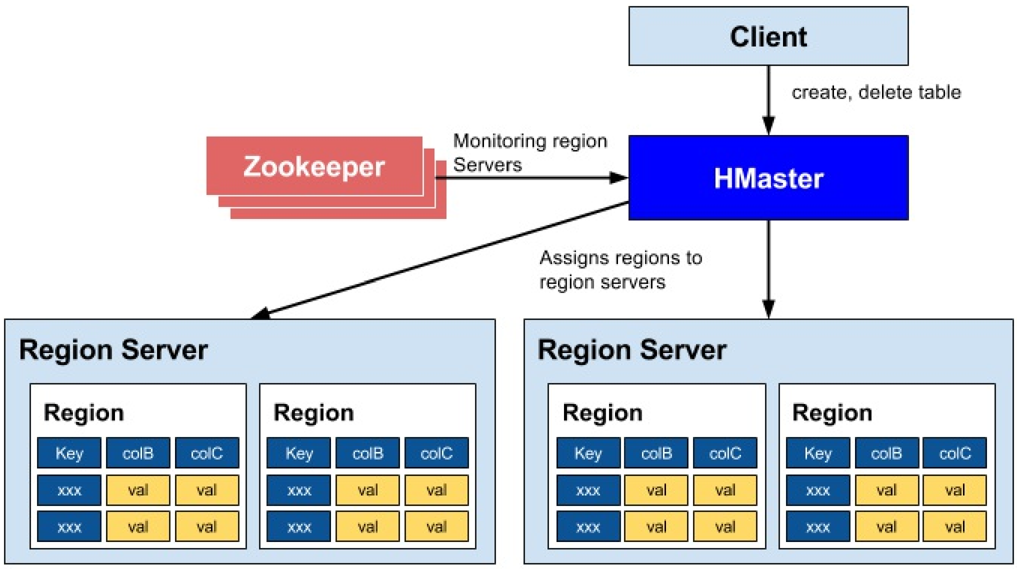



- HMaster
  - RegionServer 와 META 데이터 관리
- HRegionServer
  - Region 관리

- HResion
    - 테이블 데이터의 부분집합이며, 수평확장의 기본단위
- HLog
- HFile

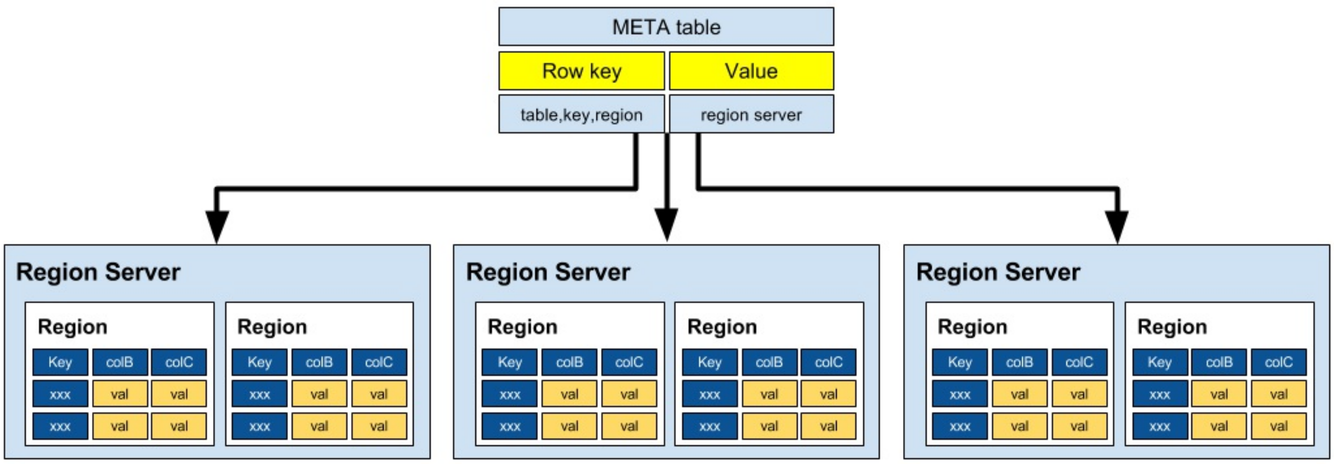
## HBase HMaster

> 각 테이블의 데이터는 HRegionServer가 관리하며, 전체 클러스터는 HMaster가 관리한다.



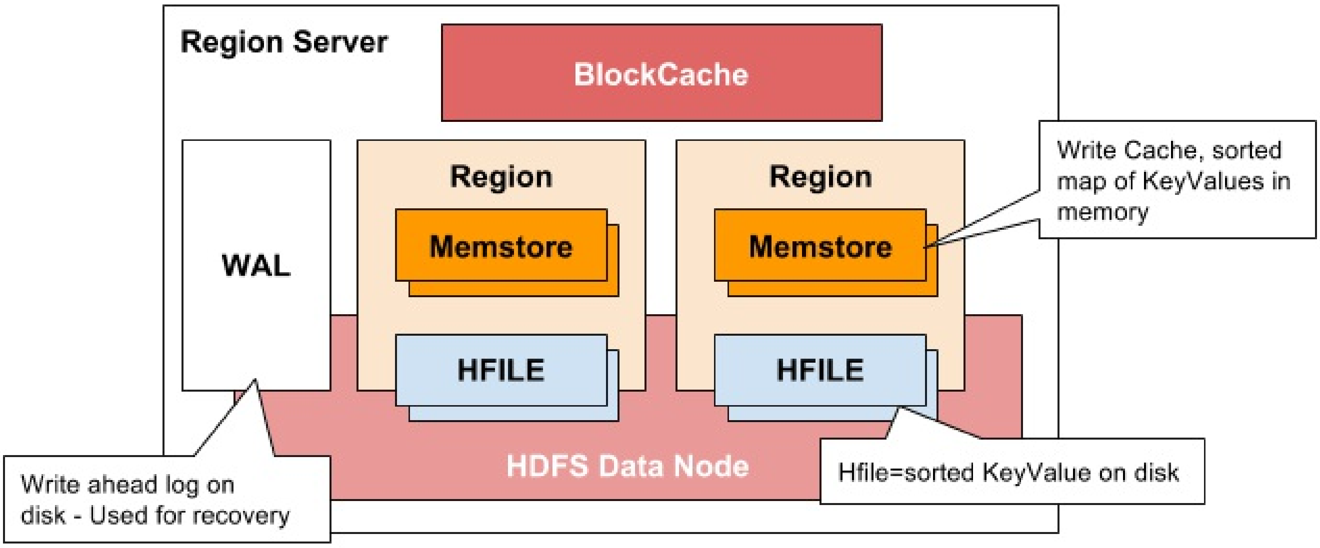

- 리전 서버들을 조정
    - 리전의 시작을 관리
    - 클러스터에 있는 모든 리전 서버들을 모니터링
- 관리 기능
    - 테이블의 생성, 삭제, 업데이트

## HBase Catalog Tables




- META 테이블
    - 클러스터에 포함된 리전의 위치정보들을 저장

## Region Server Components




- WAL(Write Ahead Log)
  - 데이터 저장 실패를 복구하기 위해서 사용
- BlockCache
  - 읽기 캐시
- MemStore
  - 쓰기 캐시
  - 각 리전의 컬럼 패밀리당 하나
- HFile

## HBASE vs RDBMS

| HBase | RDBMS |
|---|---|
| 스키마가 없다. column families만으로 이용 | 테이블의 구조를 기술하는 스키마 |
| 수평적으로 확장성이 있어 큰 테이블에 적합 | 확장하기 어려우며, 크기가 작은 테이블을 위해 생성 |
| Transaction이 존재하지 않음 | Transaction이 존재 |
| 비 일반화된 데이터 | 일반화된 데이터 |
| 덜 구조화된 데이터가 적합 | 구조화된 데이터에 적합 |
| get / put / scan 등 | SQL |
| MapReduce Join 활용 | Join에 최적화 됨 |
| RowKey만 인덱스 지원 | 임의 컬럼에 대한 인덱스 지원 |
| 초당 수십만건 Read/Write | 초당 수천건 Read/Write |
| 단일로우 트랜잭션 보장 | 다중 로우 트랜잭션 보장 |

## HBase 사용법

**1. Connect to HBase**

```
$ ./bin/hbase shell
hbase(main):001:0>
```

**2. Create a table**

```
hbase(main):001:0> create 'test', 'cf'
0 row(s) in 0.4170 seconds

=> Hbase::Table - test
```

**3. List Information About your Table**

```
hbase(main):002:0> list 'test'
TABLE
test
1 row(s) in 0.0180 seconds

=> ["test"]
```

**4. Put data into your table.**

```
hbase(main):003:0> put 'test', 'row1', 'cf:a', 'value1'
0 row(s) in 0.0850 seconds

hbase(main):004:0> put 'test', 'row2', 'cf:b', 'value2'
0 row(s) in 0.0110 seconds

hbase(main):005:0> put 'test', 'row3', 'cf:c', 'value3'
0 row(s) in 0.0100 seconds
```

**5. Scan the table for all data at once.**

```
hbase(main):006:0> scan 'test'
ROW                                     COLUMN+CELL
 row1                                   column=cf:a, timestamp=1421762485768,
value=value1
 row2                                   column=cf:b, timestamp=1421762491785,
value=value2
```

```
 row3                                       column=cf:c, timestamp=1421762496210,
value=value3
3 row(s) in 0.0230 seconds
```

**6. Get a single row of data.**

```
hbase(main):007:0> get 'test', 'row1'
COLUMN                                     CELL
 cf:a                                      timestamp=1421762485768, value=value1
1 row(s) in 0.0350 seconds
```

**7. Disable a table.**

```
hbase(main):008:0> disable 'test'
0 row(s) in 1.1820 seconds

hbase(main):009:0> enable 'test'
0 row(s) in 0.1770 seconds
```

**8. Drop the table.**

```
hbase(main):011:0> drop 'test'
0 row(s) in 0.1370 seconds
```

**9. Exit the HBase Shell.**

```
hbase(main):006:0> quit
```

## HBase Java Client Example

### HBase Data Structure

```
Family1:{
   'Qualifier1':'row1:cell_data',
   'Qualifier2':'row2:cell_data',
   'Qualifier3':'row3:cell_data'
}
Family2:{
   'Qualifier1':'row1:cell_data',
```

```
    'Qualifier2':'row2:cell_data',
    'Qualifier3':'row3:cell_data'
}
```

HBase Client Maven Dependency

```
<dependency>
  <groupId>org.apache.hbase</groupId>
  <artifactId>hbase-client</artifactId>
  <version>${hbase.version}</version>
</dependency>
<dependency>
  <groupId>org.apache.hbase</groupId>
  <artifactId>hbase</artifactId>
  <version>${hbase.version}</version>
  <type>pom</type>
</dependency>
```

### 1. Connecting to HBase

hbase-site.xml

```
<configuration>
  <property>
    <name>hbase.zookeeper.quorum</name>
    <value>hadoop01</value>
  </property>
  <property>
    <name>hbase.zookeeper.property.clientPort</name>
    <value>2181</value>
  </property>
</configuration>
```

```
Configuration config = HBaseConfiguration.create();

String path = this.getClass()
  .getClassLoader()
  .getResource("hbase-site.xml")
  .getPath();
config.addResource(new Path(path));

HBaseAdmin.checkHBaseAvailable(config);
```

### 2. Createing a Database Structure

```java
private TableName table1 = TableName.valueOf("Table1");
private String family1 = "Family1";
private String family2 = "Family2";
```

```java
Connection connection = ConnectionFactory.createConnection(config)
Admin admin = connection.getAdmin();
```

```java
HTableDescriptor desc = new HTableDescriptor(table1);
desc.addFamily(new HColumnDescriptor(family1));
desc.addFamily(new HColumnDescriptor(family2));
admin.createTable(desc);
```

**3. Adding and Retrieving Elements**

```java
byte[] row1 = Bytes.toBytes("row1")
Put p = new Put(row1);
p.addImmutable(family1.getBytes(), qualifier1, Bytes.toBytes("cell_data"));
table1.put(p);
```

```java
Get g = new Get(row1);
Result r = table1.get(g);
byte[] value = r.getValue(family1.getBytes(), qualifier1);
```

```java
Bytes.bytesToString(value)
```

**4. Scanning and Filtering**

```java
Filter filter1 = new PrefixFilter(row1);
Filter filter2 = new QualifierFilter(
  CompareOp.GREATER_OR_EQUAL,
  new BinaryComparator(qualifier1));
List<Filter> filters = Arrays.asList(filter1, filter2);
```

```java
Scan scan = new Scan();
```

```
scan.setFilter(new FilterList(Operator.MUST_PASS_ALL, filters));
scan.addColumn(family1.getBytes(), qualifier1);

ResultScanner scanner = table.getScanner(scan);
for (Result result : scanner) {
    System.out.println("Found row: " + result);
}
```

#### 5. Deleting Rows

```
Delete delete = new Delete(row1);
delete.addColumn(family1.getBytes(), qualifier1);
table.delete(delete);
```

---

## Apache Phoenix

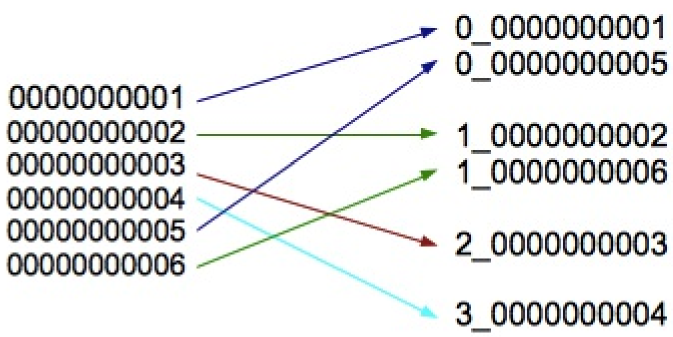
> Phoenix is an open source SQL skin for HBase.
> You use the standard JDBC APIs instead of the regular HBase client APIs to create tables, insert data, and query your HBase data.

#### 특징

- HBase 데이터에 대한 빠른 접근이 가능
  - MapReduce를 사용하지 않고 SQL 쿼리를 Native HBase 명령어로 컴파일하여 수행
- 추가적인 서버가 필요하지 않기 때문에 비교적 가벼움
- 기존에 존재하는 HBase 테이블과의 매핑이 가능

#### 장점

- JOIN
- Paging
  - OFFSET & LIMIT (ex. LIMIT 10 OFFSET 10)
- Secondary Index
- Salted Tables
  - Splitting: pre-split on salt bytes boundaries
    - ex. new_row_key = (++index % BUCKETS_NUMBER) + original_key




- Row Key Ordering: phoenix.query.rowKeyOrderSaltedTable=true
- CREATE TABLE table (a_key VARCHAR PRIMARY KEY, a_col VARCHAR) SALT_BUCKETS = 20;

**Apache Phoenix Java Client Example**

Phoenix Driver Maven Dependency

```
<dependency>
  <groupId>org.apache.phoenix</groupId>
  <artifactId>phoenix-core</artifactId>
  <version>4.13.1-HBase-1.2</version>
</dependency>
```

PhoenixExample.java

```
public class PhoenixExample {

        public static void main(String[] args) {
                // Create variables
                Connection connection = null;
                Statement statement = null;
                ResultSet rs = null;
                PreparedStatement ps = null;

                try {
                        connection =
DriverManager.getConnection("jdbc:phoenix:demo");
                        statement = connection.createStatement();
                        statement.executeUpdate("create table javatest (mykey
integer not null primary key, mycolumn varchar)");
                        statement.executeUpdate("upsert into javatest values
(1,'Hello')");
                        statement.executeUpdate("upsert into javatest values
(2,'Java Application')");
                        connection.commit();

                        ps = connection.prepareStatement("select * from
javatest");
```

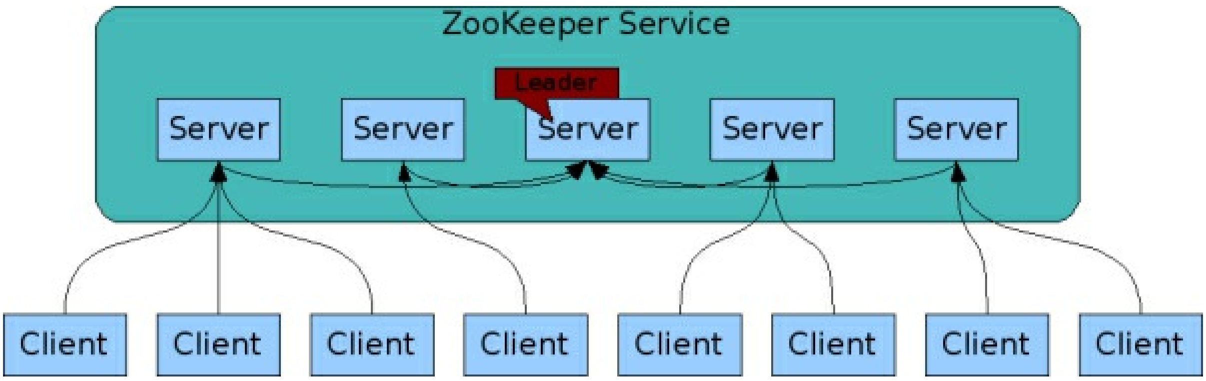
```
                            rs = ps.executeQuery();

                            System.out.println("Table Values");
                            while (rs.next()) {
                                    Integer myKey = rs.getInt(1);
                                    String myColumn = rs.getString(2);
                                    System.out.println("\tRow: " + myKey + " = " +
myColumn);
                            }
                    } catch (SQLException e) {
                            e.printStackTrace();
                    } finally {
                            try {
                                    ps.close();
                                    rs.close();
                                    statement.close();
                                    connection.close();
                            } catch (Exception e) {
                            }
                    }
            }
}
```

## 2.3 ZooKeeper

> A Distributed Coordination Service for Distributed Applications

- 설정 정보 관리
- 노드 리스트 관리
- 리더선정

### ZooKeeper Architecture

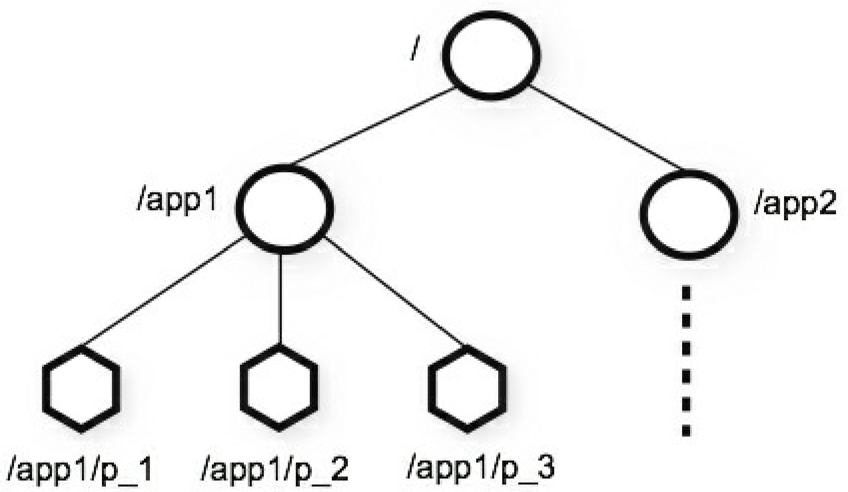



### Desigh Goals

- ZooKeeper is simple.
    - ZooKeeper allows distributed processes to coordinate with each other through a shared hierarchal namespace which is organized similarly to a standard file system.

- Zookeeper is replicated.
  - ZooKeeper itself is intended to be replicated over a sets of hosts called an ensemble.
- Zookeeper is ordered.
  - ZooKeeper stamps each update with a number that reflects the order of all ZooKeeper transactions.
- Zookeeper is fast.
  - It is especially fast in "read-dominant" workloads.

## Data model and the hierarchical namespace




## Nodes and ephemeral nodes

- each node in a ZooKeeper namespace can have data associated with it as well as children.
- These znodes exists as long as the session that created the znode is active.

## Simple API

| operation | desc |
| --- | --- |
| create | creates a node at a location in the tree |
| delete | deletes a node |
| exists | tests if a node exists at a location |
| get data | reads the data from a node |
| set data | writes data to a node |
| get children | retrieves a list of children of a node |
| sync | waits for data to be propagated |

## Example

Maven Dependency

```xml
<dependency>
        <groupId>org.apache.zookeeper</groupId>
        <artifactId>zookeeper</artifactId>
        <version>3.4.8</version>
</dependency>
```

ZNodeTest.java

```java
public class ZNodeTest {

    public static void main(String[] args) {
        int sessionTimeout = 10 * 100;

        // 1. ZooKeeper 서버(클러스터)에 연결
        ZooKeeper zk = null;

        try {
            zk = new ZooKeeper("demo:2181", sessionTimeout, null);

            // 2. Test01 znode가 존재하지 않으면 /test01, /test02 생성
            if (zk.exists("/test01", false) == null) {
                zk.create("/test01", "test01_data".getBytes(),
Ids.OPEN_ACL_UNSAFE, CreateMode.PERSISTENT);
                zk.create("/test02", "test02_data".getBytes(),
Ids.OPEN_ACL_UNSAFE, CreateMode.PERSISTENT);
            }

            // 3 /test01 노드의 자식 노드로 sub01, sub02 생성
            zk.create("/test01/sub01", null, Ids.OPEN_ACL_UNSAFE,
CreateMode.EPHEMERAL);
            zk.create("/test01/sub02", null, Ids.OPEN_ACL_UNSAFE,
CreateMode.EPHEMERAL);

            // 4. /test01 노드의 데이터 가져오기
            byte[] test01Data = zk.getData("/test01", false, null);
            System.out.println("getData [/test01]: " + new
String(test01Data));

            // 5. /test01/sub01 노드의 데이터를 새로운 값으로 설정
            zk.setData("/test01/sub01", "this new Data".getBytes(), -1);
            byte[] subData = zk.getData("/test01/sub01", false, null);
            System.out.println("getData after setData [/test01/sub01]: " + new
String(subData));

            // 6. 노드가 존재하는지 확인
            System.out.println("exist [/test01/sub01]: " +
(zk.exists("/test01/sub01", false) != null));
            System.out.println("exist [/test01/sub03]: " +
(zk.exists("/test01/sub03", false) != null));
```

```java
            // 7. /test01의 자식노드 목록 가져오기
            List<String> children = zk.getChildren("/test01", false);
            for (String eachChildren : children) {
                System.out.println("getChildren [/test01]: " + eachChildren);
            }
        } catch (IOException | KeeperException | InterruptedException e) {
            e.printStackTrace();
        } finally {
            // 8. zk 종료
            try {
                zk.close();
            } catch (InterruptedException e) {
                e.printStackTrace();
            }
        }
    }
}
```

---

## Storm 을 이용한 실시간 데이터 분석

> Apache Storm is a free and open source distributed realtime computation system.

## 데이타 스트림과 실시간 분석

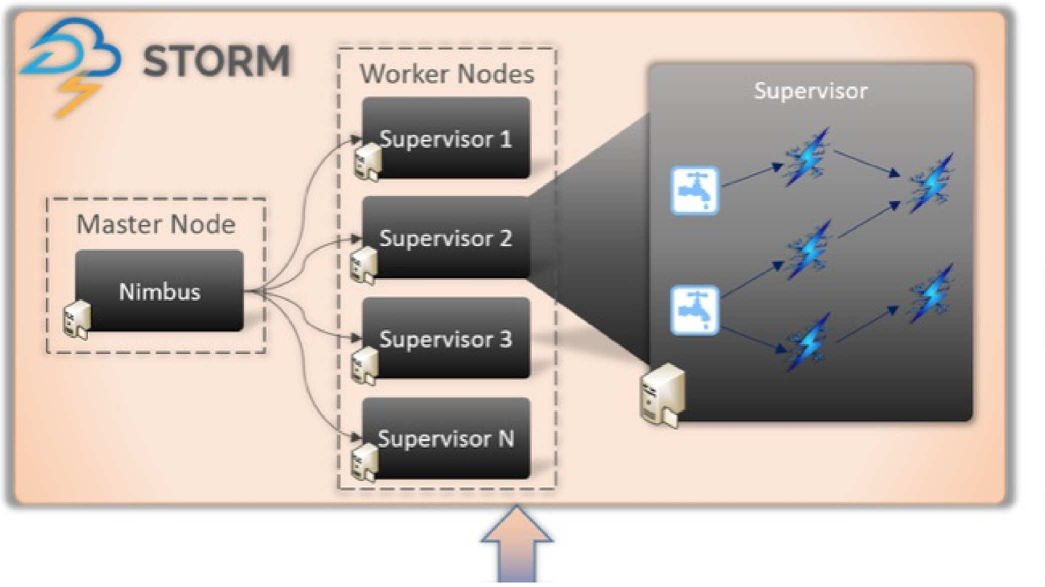
- 시간을 축으로 하여 계속해서 생성되는 데이터
- 배치 분석 vs. 실시간 분석
- 마케팅과 같이 실시간 대응이 중요한 경우에는 **데이터 스트림**을 **실시간** 으로 분석
- EX> 이벤트 감지를 통한 이상 거래 탐지(Fraud Detection)

## Storm 특징

- Integrates
  - Storm integrates with any queueing system and any database system.
- Simple API
- Scalable
  - Storm was benchmarked at processing one million 100 byte messages per second per node on hardware with the following specs:
    - Processor: 2x Intel E5645@2.4Ghz
    - Memory: 24 GB
- Fault tolerant
- Guarantees data processing
  - Using Trident, a higher level abstraction over Storm's basic abstractions, you can achieve exactly-once processing semantics.
- Use with any language
- Easy to deploy and operate
- Free and open source

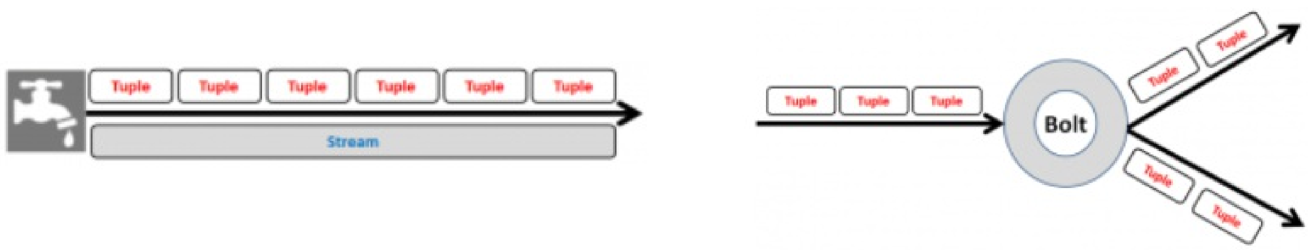
- Apache Storm is a free and open source project licensed under the Apache License, Version 2.0

## Storm Architecture



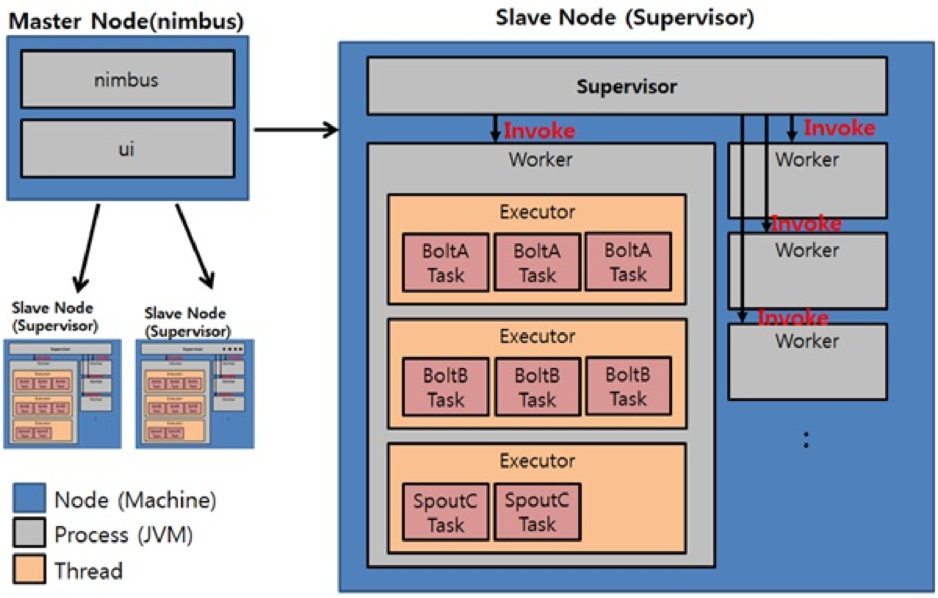

1. Nimbus -> Master Node
2. Supervisor -> Worker Node

## Storm Components




1. Spout: Spout is the entry point in a storm topology.
2. Bolt: Bolt contains the actual processing logic.
3. Topology: Topology is a network of spouts and bolts
4. Stream: A stream is an unbounded sequence of tuples
5. Tuple: Tuple is the most basic data structure in storm . Its a named list of values.

## Storm Parallelism




- Node
  - Nimbus나 Supervisor 프로세스가 기동되는 물리적인 서버
- Worker
  - Supervisor가 있는 노드에서 기동되는 자바 프로세스
- Executor
  - Worker내에서 수행되는 자바 쓰레드
- Task
  - Bolt 및 Spout 객체

## Storm Example

### 1. HelloTopology Example

pom.xml

```
<dependency>
  <groupId>org.apache.storm</groupId>
  <artifactId>storm-core</artifactId>
  <version>1.1.1</version>
  <scope>provided</scope>
</dependency>
```

HelloSpout.java

```
public class HelloSpout extends BaseRichSpout {
        private SpoutOutputCollector collector;

        public void open(Map conf, TopologyContext context,
SpoutOutputCollector collector) {
                this.collector = collector;
        }
```

```java
	public void nextTuple() {
		this.collector.emit(new Values("Hello World!"));
	}

	public void declareOutputFields(OutputFieldsDeclarer declarer) {
		declarer.declare(new Fields("say"));
	}
}
```

HelloBolt.java

```java
public class HelloBolt extends BaseBasicBolt {

	private static final long serialVersionUID = 1L;

	public void execute(Tuple tuple, BasicOutputCollector collector) {
		String value = tuple.getStringByField("say");
		System.out.println("Tuple value is " + value);
	}

	public void declareOutputFields(OutputFieldsDeclarer declarer) {
	}
}
```

HelloTopology.java

```java
public class HelloTopology {
	public static void main(String args[]) throws Exception {
		TopologyBuilder builder = new TopologyBuilder();
		builder.setSpout("HelloSpout", new HelloSpout(), 2);
		builder.setBolt("HelloBolt", new HelloBolt(),
4).shuffleGrouping("HelloSpout");

		Config conf = new Config();
		conf.setDebug(true);

		// If there are arguments, we are running on a cluster
		if (args != null && args.length > 0) {
			// parallelism hint to set the number of workers
			conf.setNumWorkers(3);
			// submit the topology
			StormSubmitter.submitTopology(args[0], conf,
builder.createTopology());
		}
		// Otherwise, we are running locally
		else {
			LocalCluster cluster = new LocalCluster();
```

```
                            cluster.submitTopology("HelloTopologyLocal", conf,
builder.createTopology());
                            Utils.sleep(10000);

                            // kill the LearningStormTopology
                            cluster.killTopology("HelloTopologyLocal");
                            // shutdown the storm test cluster
                            cluster.shutdown();
                    }
            }
}
```

2. 빌드 및 배포

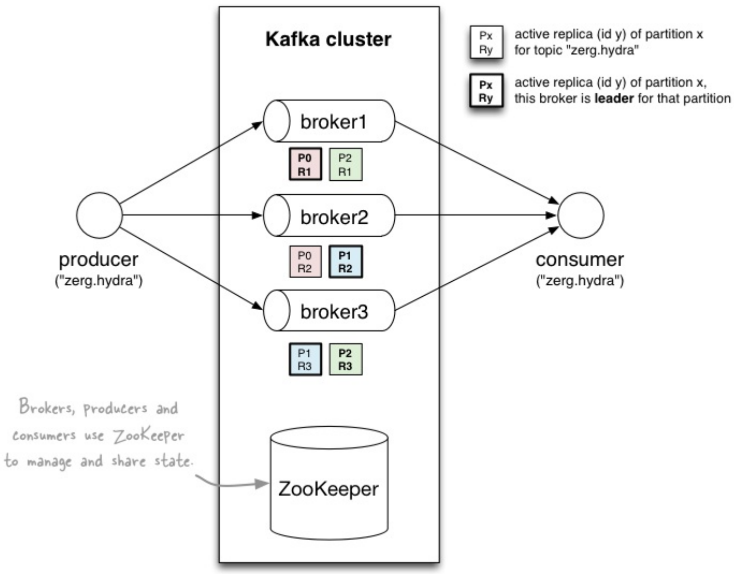
```
$ mvn clean package -DskipTests=true
```

```
$ storm jar storm-0.0.1-SNAPSHOT.jar hello.HelloTopology HelloTopology
```

# Kafka 및 Redis 활용

# 4.1 Kafka

> A distributed streaming platform

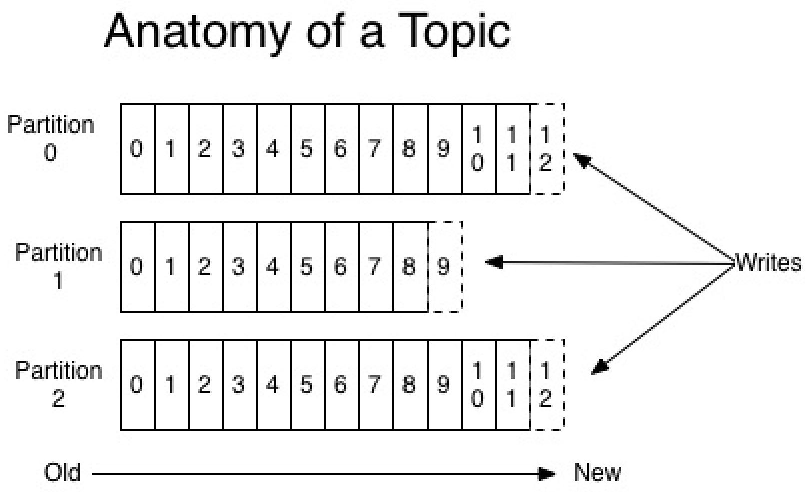



First a few concepts:

- Kafka is run as a cluster on one or more servers.
- The Kafka cluster stores streams of records in categories called topics.

- Each record consists of a key, a value, and a timestamp.

Topics and Logs




Producers

Consumers

## 4.2 Kafka-Storm Example

pom.xml

```
<dependency>
  <groupId>org.apache.storm</groupId>
  <artifactId>storm-core</artifactId>
  <version>1.1.1</version>
  <scope>provided</scope>
</dependency>
```

CutLogBolt.java

```
public class CutLogBolt extends BaseBasicBolt {

        private static final long serialVersionUID = 1L;

        @Override
        public void execute(Tuple input, BasicOutputCollector collector) {

                String[] splitArray = input.getString(0).split(";");
                String key = "";
                String doctype = "";

                for (int i = 0; i < splitArray.length; i++) {
```

```
                        if (splitArray[i].contains("key"))
                                key = splitArray[i];
                        if (splitArray[i].contains("doctype"))
                                doctype = splitArray[i];
                }
                collector.emit(new Values(key, doctype));
        }

        @Override
        public void declareOutputFields(OutputFieldsDeclarer declarer) {
                declarer.declare(new Fields("key", "doctype"));
        }
}
```

ClassifyKeyBolt.java

```
public class ClassifyKeyBolt extends BaseBasicBolt {

        private static final long serialVersionUID = 1L;

        @Override
        public void execute(Tuple input, BasicOutputCollector collector) {
                String[] splitdoctype =
input.getStringByField("doctype").split(":");
                String[] splitkey = input.getStringByField("key").split(":");
                if (splitkey.length == 2 && splitdoctype.length == 2) {
                        String doctype = splitdoctype[1].trim();
                        String key = splitkey[1].trim();
                        // System.err.println(key + ":" + doctype);
                        collector.emit(new Values(key + ":" + doctype));
                }
        }

        @Override
        public void declareOutputFields(OutputFieldsDeclarer declarer) {
                declarer.declare(new Fields("subdoctype"));
        }
}
```

DoctypeCountBolt.java

```
public class DoctypeCountBolt extends BaseBasicBolt {

        private static final long serialVersionUID = 1L;

        Map<String, Integer> docMap = new HashMap<String, Integer>();

        @Override
```

```
        public void execute(Tuple input, BasicOutputCollector collector) {

                String doctype = input.getStringByField("subdoctype");

                Integer count = docMap.get(doctype);
                if (count == null)
                        count = 0;

                count++;

                docMap.put(doctype, count);
                System.out.println(docMap);
                collector.emit(new Values(docMap));
        }

        @Override
        public void declareOutputFields(OutputFieldsDeclarer declarer) {
                declarer.declare(new Fields("docmap"));
        }
}
```

MonitorTopology.java

```
public class MonitorTopology {

        public static void main(String[] args) throws Exception {

                String zkUrl = "demo:2181";
                String brokerUrl = "demo:9092";

                System.out.println("Using Kafka zookeeper url: " + zkUrl + "
broker url: " + brokerUrl);

                ZkHosts hosts = new ZkHosts(zkUrl);

                SpoutConfig spoutConfig = new SpoutConfig(hosts, "onlytest",
"/onlytest", UUID.randomUUID().toString());
                spoutConfig.scheme = new SchemeAsMultiScheme(new
StringScheme());
                KafkaSpout kafkaSpout = new KafkaSpout(spoutConfig);

                TopologyBuilder builder = new TopologyBuilder();
                builder.setSpout("spout", kafkaSpout, 1);
                builder.setBolt("cutbolt", new CutLogBolt(),
2).shuffleGrouping("spout");
                builder.setBolt("classifybolt", new ClassifyKeyBolt(),
2).fieldsGrouping("cutbolt", new Fields("key", "doctype"));
                builder.setBolt("docbolt", new DoctypeCountBolt(),
2).fieldsGrouping("classifybolt", new Fields("subdoctype"));
```

```
                Config conf = new Config();
                conf.setDebug(true);

                List<String> nimbus_seeds = new ArrayList<String>();
                nimbus_seeds.add("nimbus url");
                if (args != null && args.length > 0) {
                        conf.setNumWorkers(3);
                        StormSubmitter.submitTopologyWithProgressBar(args[0],
conf, builder.createTopology());
                } else {
                        conf.setNumWorkers(3);
                        StormSubmitter.submitTopology("onlytest", conf,
builder.createTopology());
                }
        }
}
```

빌드 및 배포

```
$ mvn clean package -DskipTests=true
$ storm jar storm-0.0.1-SNAPSHOT.jar monitor.MonitorTopology MonitorTopology
```

## 4.2 Redis(Remote Dictionary Server)

> Redis is an open source (BSD licensed), **in-memory data structure store**, used as a database, **cache** and message broker

특징

- key-value data store
- value can be a string, list, set, sorted set or hash

### Redis Java Example

pom.xml

```
<dependency>
    <groupId>redis.clients</groupId>
    <artifactId>jedis</artifactId>
    <version>2.9.0</version>
</dependency>
```

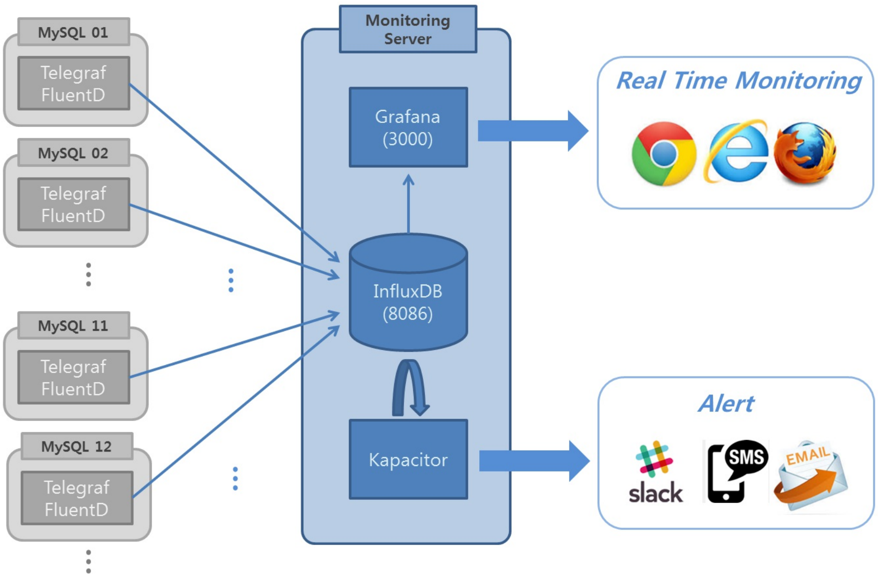
HelloRedis.java

```
public class HelloRedis {
```

```
        public static void main(String args[]) {
                JedisPool jedisPool = new JedisPool(new JedisPoolConfig(),
"192.168.33.10");
                Jedis jedis = jedisPool.getResource();

                try {
                        jedis.set("test1", "testValue1");
                        jedis.set("test2", "testValue2");
                        System.out.println("jedis Value 1 : " +
jedis.get("test1"));
                        System.out.println("jedis Value 2 : " +
jedis.get("test2"));
                        System.out.println(jedis.dbSize());
                } catch (JedisConnectionException e) {
                } finally {
                        if (null != jedis) {
                                jedisPool.close();
                        }
                }

                jedisPool.destroy();
        }
}
```

## Grafana 와 InfluxDB를 이용한 대시보드 구성

## Dashboard Architecture




[출처링크] http://www.popit.kr/influxdb_telegraf_grafana_2/

## Grafana

> The open platform for beautiful analytics and monitoring

> The leading open source software for the time series analytics

## InfluxDB

> InfluxDB is a Time Series Database built from the ground up to handle high write & query loads.

## Telegraf

> Telegraf is the Agent for Collecting & Reporting Metrics & Data

## Reference

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