HBASE CON2012

Supporting HBase:
How to Stabilize, Diagnose and Repair

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5/22/12

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Who Are We?

- Jeff Bean
    - Designated Support Engineer, Cloudera
    - Education Program Lead, Cloudera

- Kathleen Ting
    - Support Manager, Cloudera
    - ZooKeeper Subject Matter Expert

- Jonathan Hsieh
    - Software Engineer, Cloudera
    - Apache HBase Committer and PMC member

Outline

- Preventative HBase Medicine:
  - Tips for a healthy HBase

- The HBase Triage:
  - Fixes for acute HBase pains

- The HBase Surgery:
  - Repairing a Corrupted HBase

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- Preventative HBase Medicine:
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- The HBase Triage:
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- The HBase Surgery:
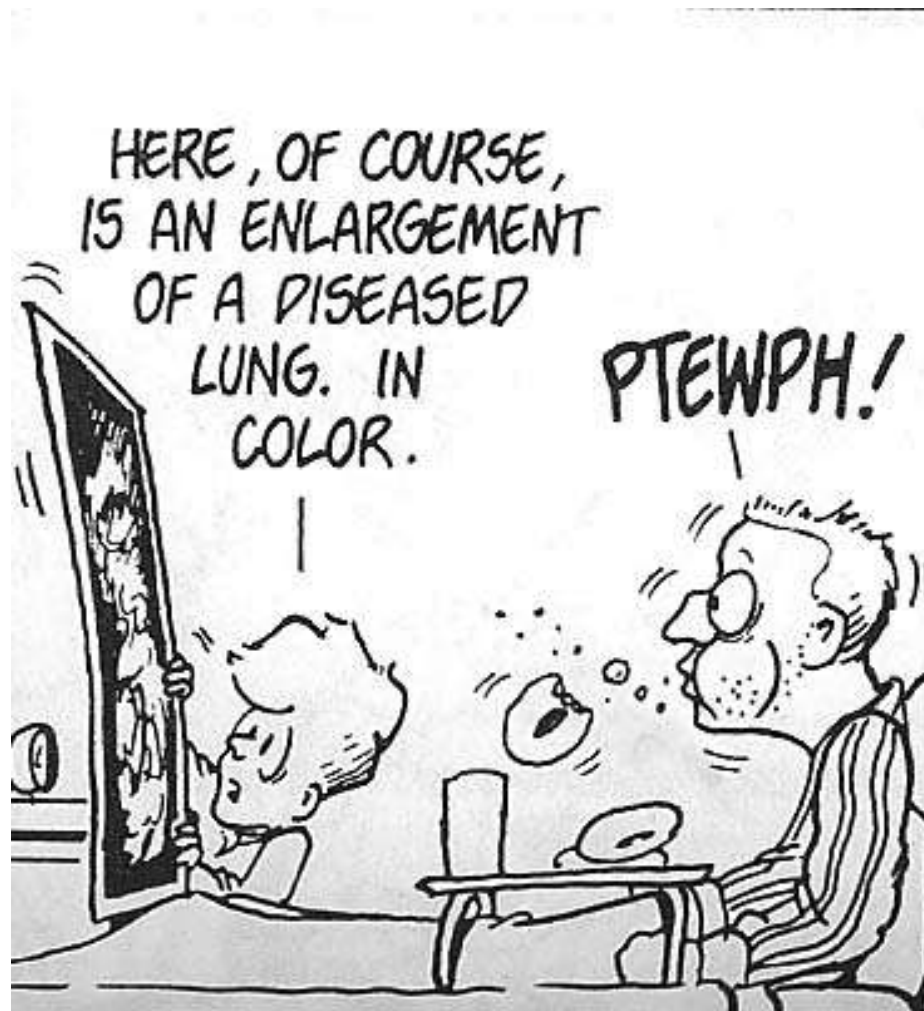 - Repairing a Corrupted HBase

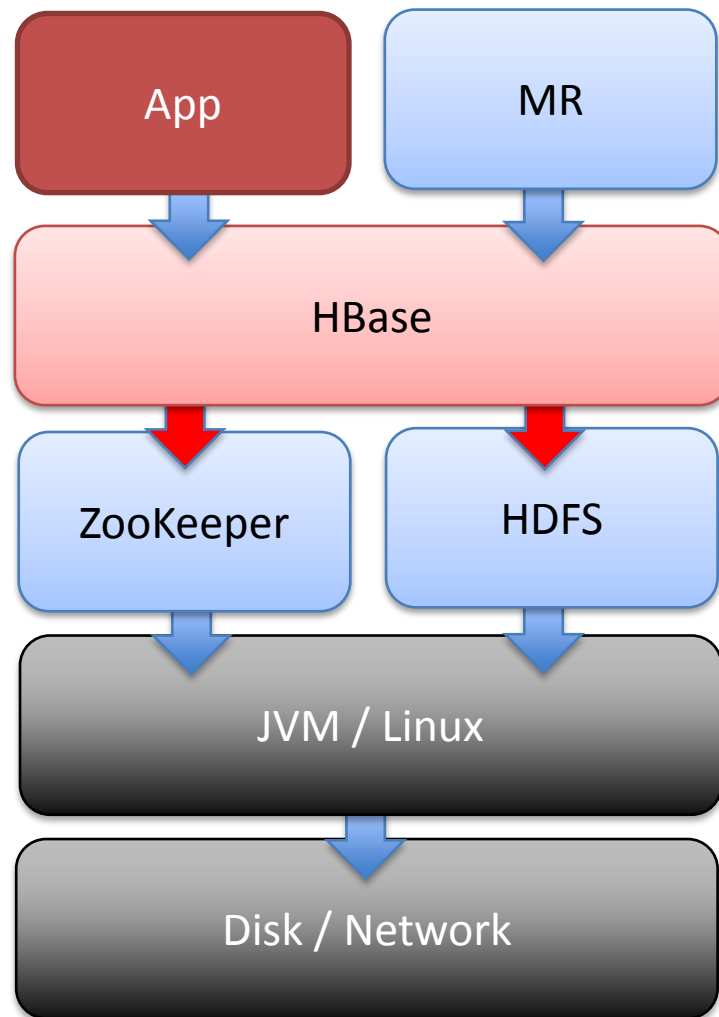# "Monitor your system, exercise your workload, and eat your vegetables."

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HBase Cross-Section

# Doctor's Advice: "A ounce of prevention worth a pound of cure."

- Understand your workload and test for it
- Size your cluster properly (see Cluster Sizer)
- Monitor, alert, and manage your cluster with Ganglia, Nagios, and/or Cloudera Manager
  - Don't be Dr. House!

A Case Study

# Symptom: Long Running MapReduce job with blacklisted TaskTrackers

TaskTracker	No. of Failures
NodeX	4
NodeY	3
NodeQ	7
NodeB	10
NodeP	8
NodeV	6

App   MR

HBase

ZK   HDFS

JVM / Linux

Disk / Network
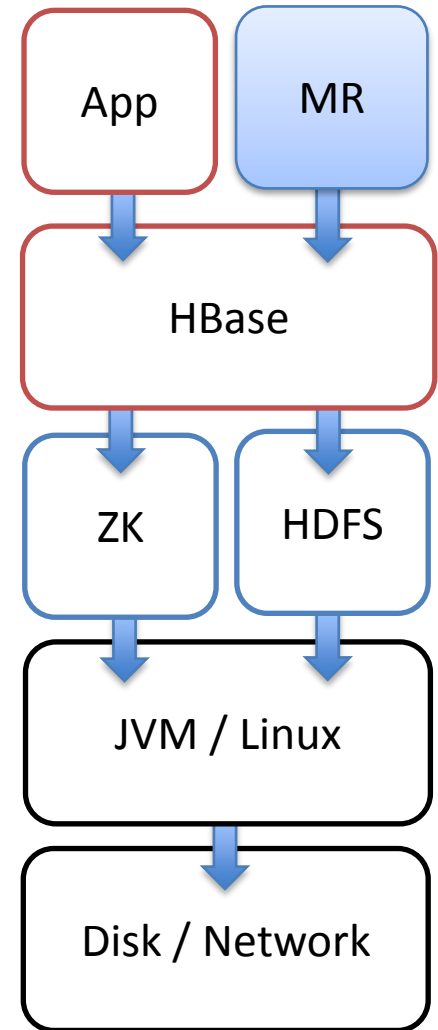
Symptom: Node B Task Logs

$ find . | xargs grep "giving up"

./attempt_201107261334_0221_m_000962_1/syslog:2011-08-02
11:09:34,248 INFO org.apache.hadoop.ipc.HbaseRPC: Server at
NodeA:60020 could not be reached after 1 tries, giving up.

./attempt_201107261334_0221_m_000962_1/syslog:2011-08-02
11:09:37,328 INFO org.apache.hadoop.ipc.HbaseRPC: Server at
NodeA:60020 could not be reached after 1 tries, giving up.

./attempt_201107261334_0221_m_000962_1/syslog:2011-08-02
11:09:40,465 INFO org.apache.hadoop.ipc.HbaseRPC: Server at
NodeA:60020 could not be reached after 1 tries, giving up.

App   MR

HBase

ZK   HDFS

JVM / Linux

Disk / Network
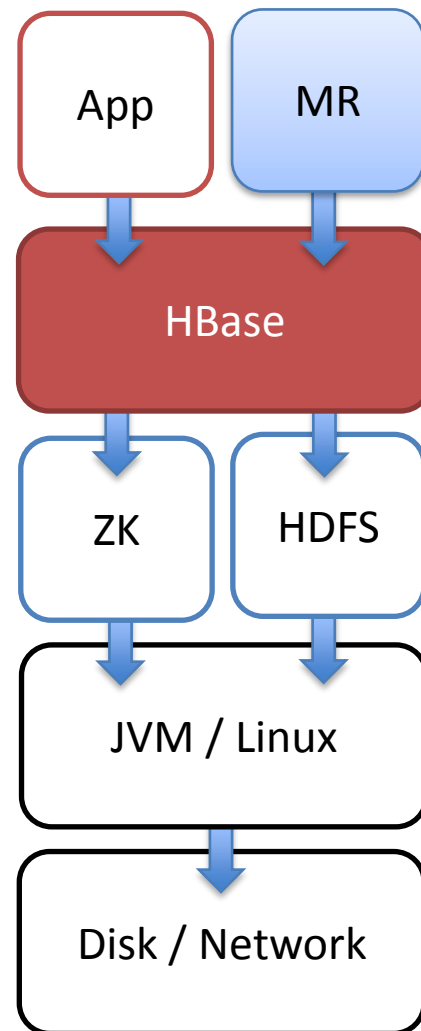
Symptom: RegionServer logs of Node A:

2011-08-02 11:04:20,324 FATAL org.apache.hadoop.hbase.regionserver.HRegionServer

: ABORTING region server serverName=**NodeA**,60020,1312228900706, load=(requests=10847, regions=342, usedHeap=8193, maxHeap=15350): regions

erver:60020-0x4316487a73e1626 regionserver:60020-0x4316487a73e1626 received expired from **ZooKeeper**, aborting

org.apache.zookeeper.KeeperException$SessionExpiredEx ception: KeeperErrorCode = Session expired
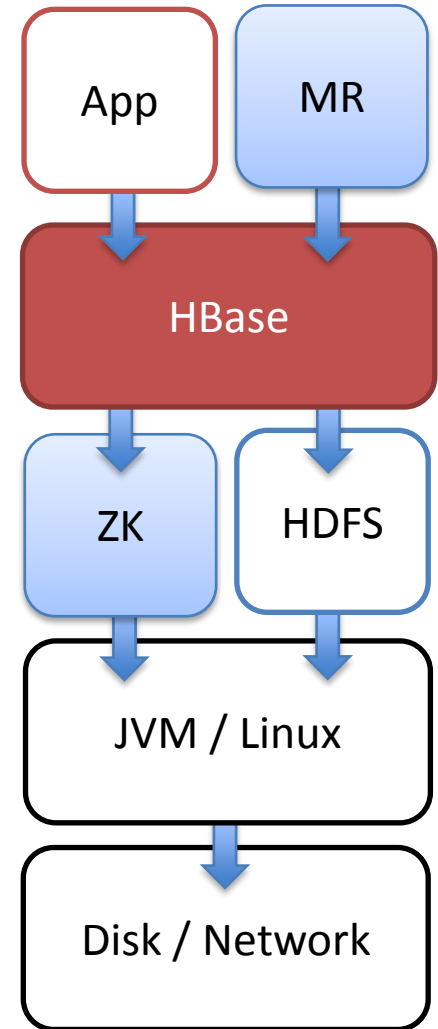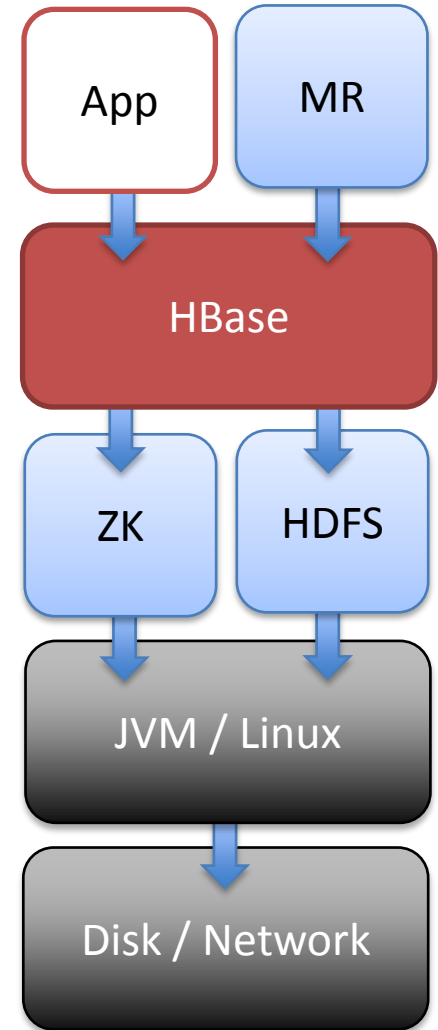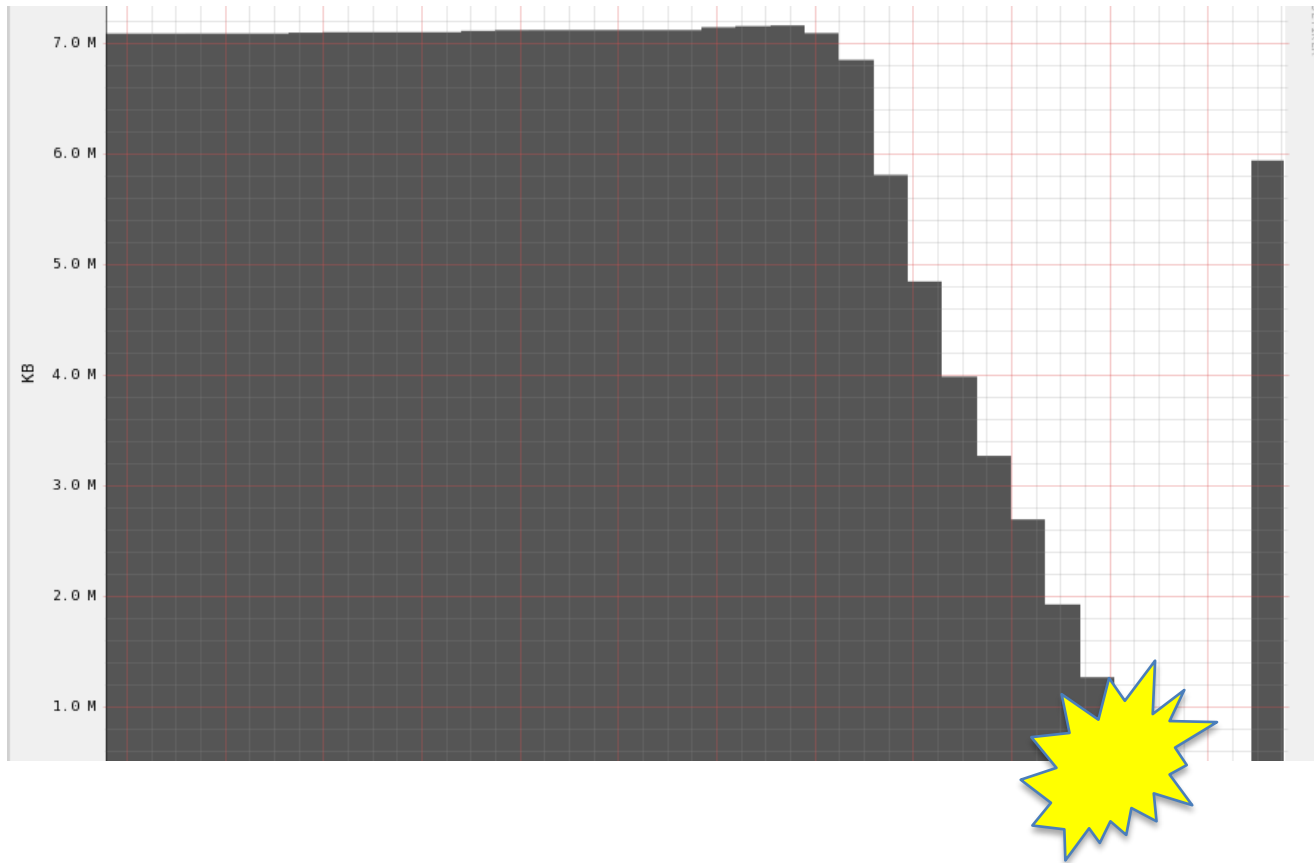
Cascading failure! Some other node says ouch...

2011-08-01 12:55:39,356 INFO org.apache.hadoop.hbase.regionserver.ShutdownHook:
    Shutdown hook starting; hbase.shutdown.hook=true; fsShutdownHook=Thread[Thread-
    15,5,main]

2011-08-01 12:55:39,629 INFO org.apache.hadoop.hbase.regionserver.HRegionServer:
    STOPPED: Shutdown hook

2011-08-01 12:55:39,629 INFO org.apache.hadoop.hbase.regionserver.ShutdownHook:
    Starting fs shutdown hook thread.

2011-08-01 12:55:39,695 ERROR org.apache.hadoop.hdfs.**DFSClient**: Exception closing file
    /hbase/.logsNodeA,60020,1311651881177NodeA%3A60020.1311656326143 :
    java.io.IOException: Error Recovery for block blk_1102151039331207284_16350929
    failed because recovery from primary datanode NodeA:50010 failed 6 times. Pipeline
    was NodeA:50010. Aborting...

java.io.IOException: Error Recovery for block blk_1102151039331207284_16350929 failed
    because recovery from primary datanode NodeA:50010 failed 6 times. Pipeline was
    NodeA:50010. Aborting...

    at
    org.apache.hadoop.hdfs.**DFSClien**t$DFSOutputStream.processDatanodeError(DFSCli
    ent.java:2841)

    at
    org.apache.hadoop.hdfs.**DFSClien**t$DFSOutputStream.access$1600(DFSClient.java:2
    305)

    at
    org.apache.hadoop.hdfs.**DFSClien**t$DFSOutputStream$DataStreamer.run(DFSClient.j
    ava:2477)

2011-08-01 12:55:39,842 INFO org.apache.hadoop.hbase.regionserver.ShutdownHook:
    Shutdown hook finished.

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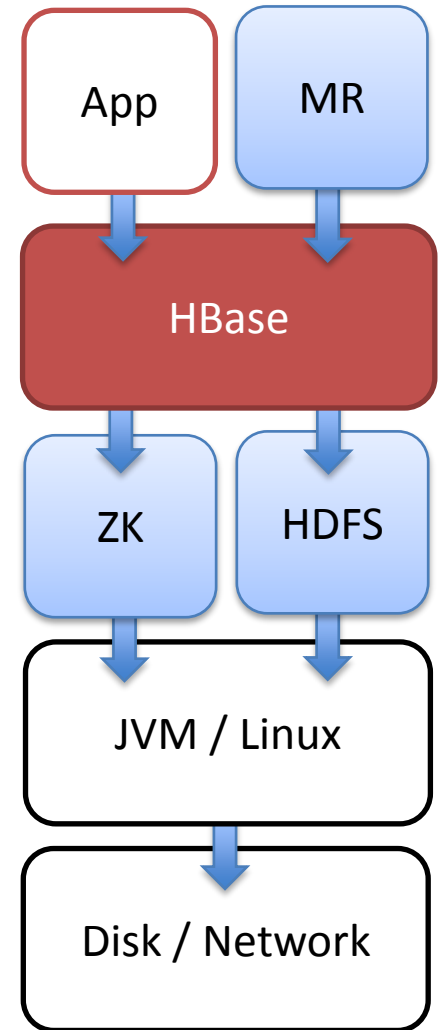
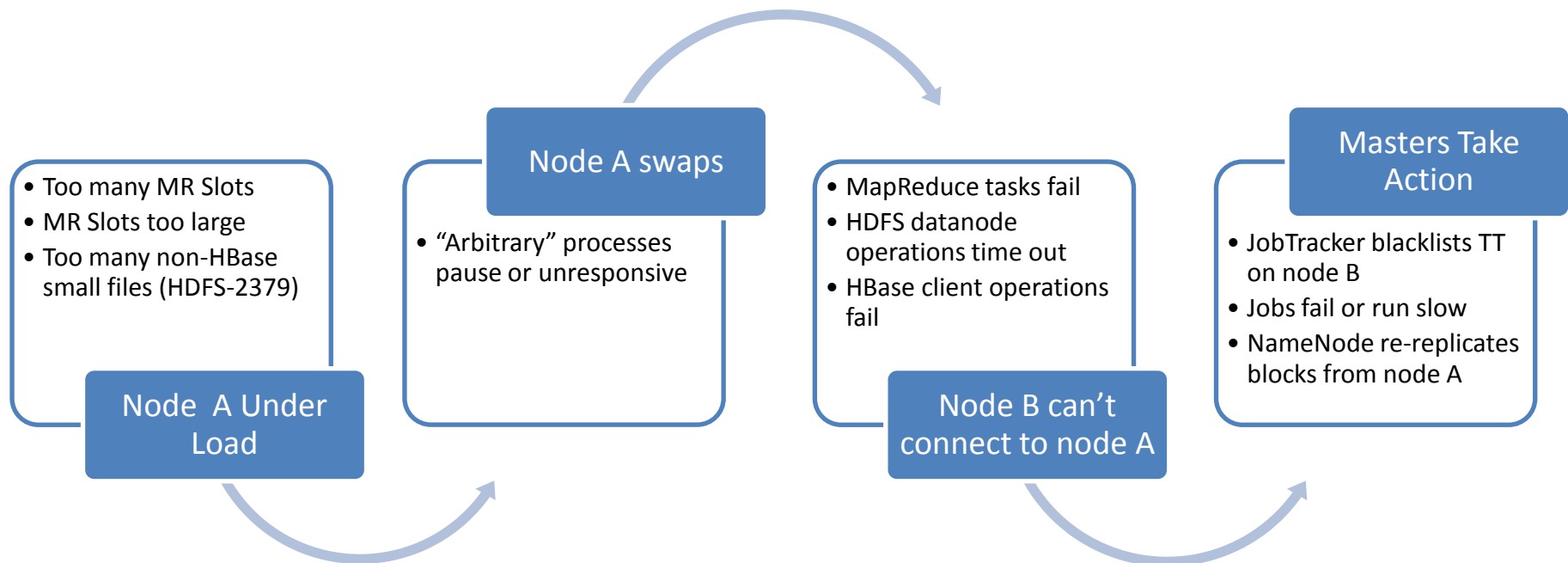# Symptom: Ganglia Memory Graph on Node A...
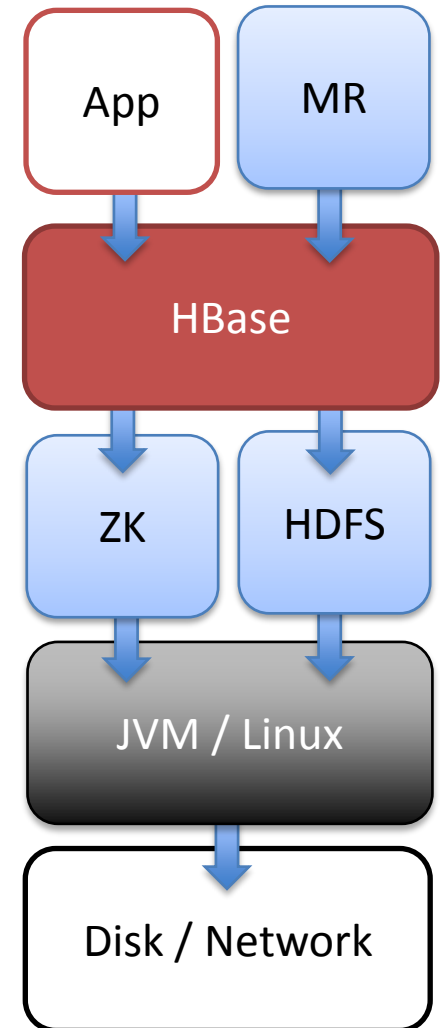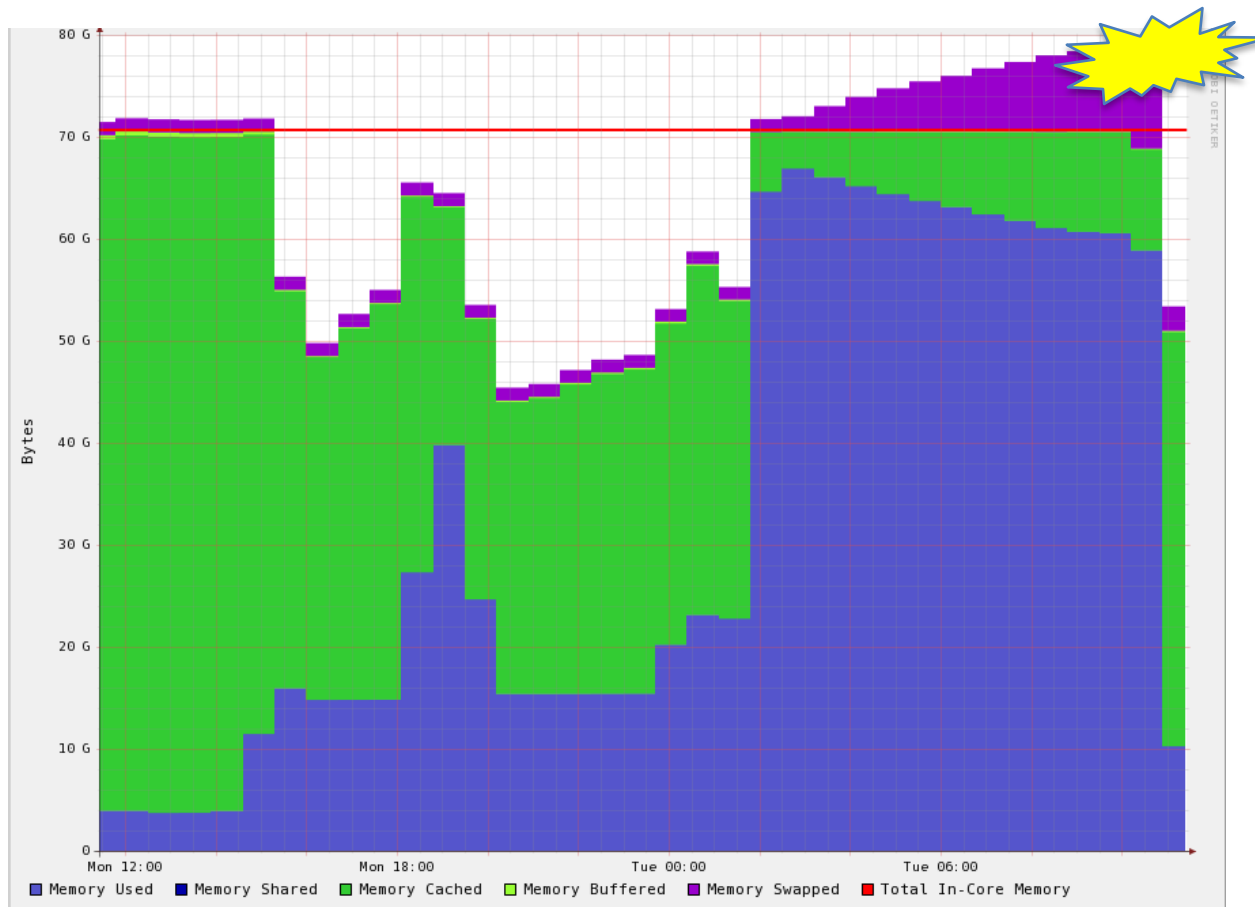
Symptom: Ganglia swap_free on Node A...

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A Case study: Radiant Pain
"I was having back pains, and it turned out to be my heart!"

Node A Under Load
- Too many MR Slots
- MR Slots too large
- Too many non-HBase small files (HDFS-2379)

Node A swaps
- "Arbitrary" processes pause or unresponsive

Node B can't connect to node A
- MapReduce tasks fail
- HDFS datanode operations time out
- HBase client operations fail

Masters Take Action
- JobTracker blacklists TT on node B
- Jobs fail or run slow
- NameNode re-replicates blocks from node A

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Event Trail and Evidence Trail

| Node A condition (load) | Node A event (swap) | Node B symptom (connect) | Master Action (blacklist) |

?!? !!!

| Node A Monitoring | Transient swap not logged! | Node B Logs | Master Logs and UIs |

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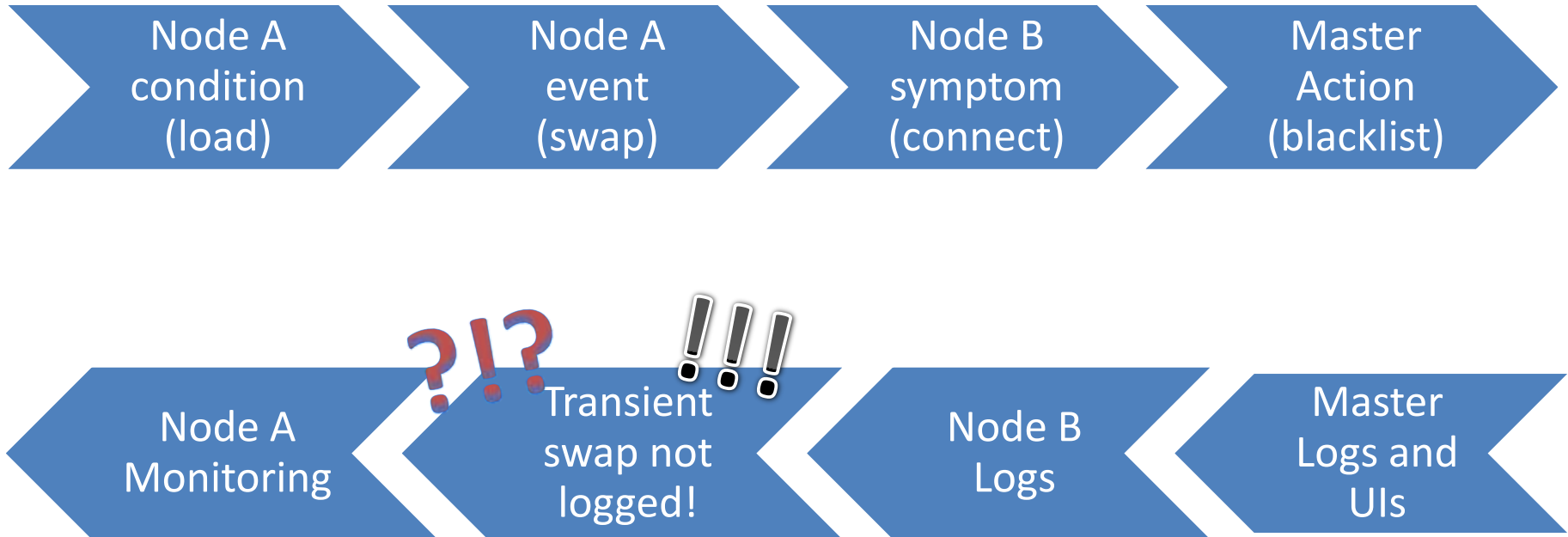
DOs and DON'Ts for keeping HBase Healthy

DOs

- Monitor and Alert

- Optimize network

- Know your logs

DON'Ts

- Swap

- Oversubscribe MR

- Share the network

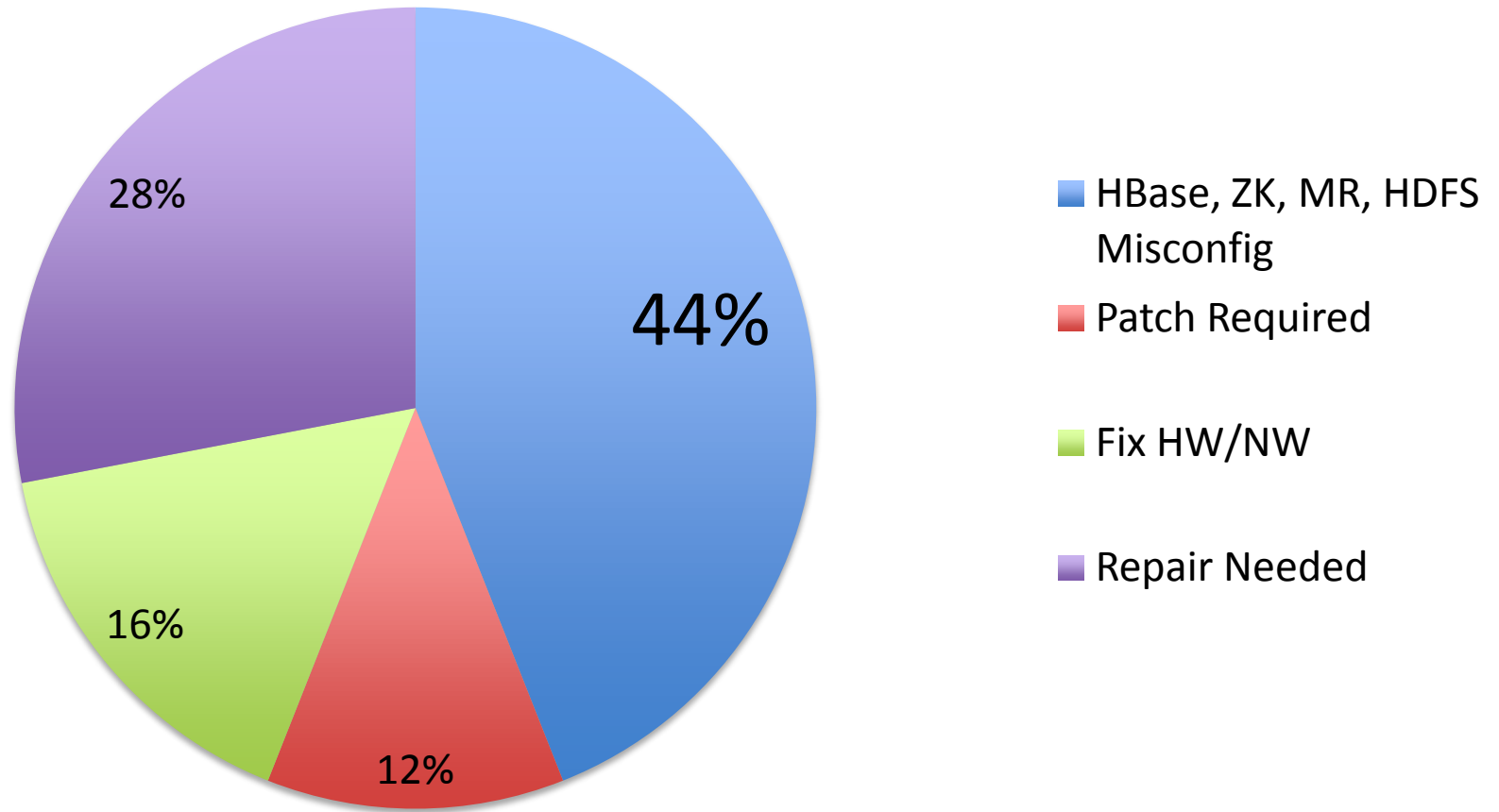cloudera

Outline

- Preventative HBase Medicine:
  - Tips for a healthy HBase

- The HBase Triage:
  - Fixes for acute HBase pains

- The HBase Surgery:
  - Repairing a Corrupted HBase

"Cloudera 911 here, how can we help?"

HBase Support Tickets

- **44%** — HBase, ZK, MR, HDFS Misconfig
- **12%** — Patch Required
- **16%** — Fix HW/NW
- **28%** — Repair Needed

Legend:
- ■ HBase, ZK, MR, HDFS Misconfig
- ■ Patch Required
- ■ Fix HW/NW
- ■ Repair Needed

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Understanding the logs helps us diagnose issues

- Related events logged by different processes in different places
- Log messages point at each other
  - HDFS accesses by RS logged by NN and DN
  - HBase accesses by MR logged by JT, RS, NN, ZK
  - ZK logs indicate HBase health

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The HBase Triage: Fixes for acute HBase pains

- Severe Pain

- Complete Unconsciousness

The HBase Triage: Fixes for acute HBase pains

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- Complete Unconsciousness
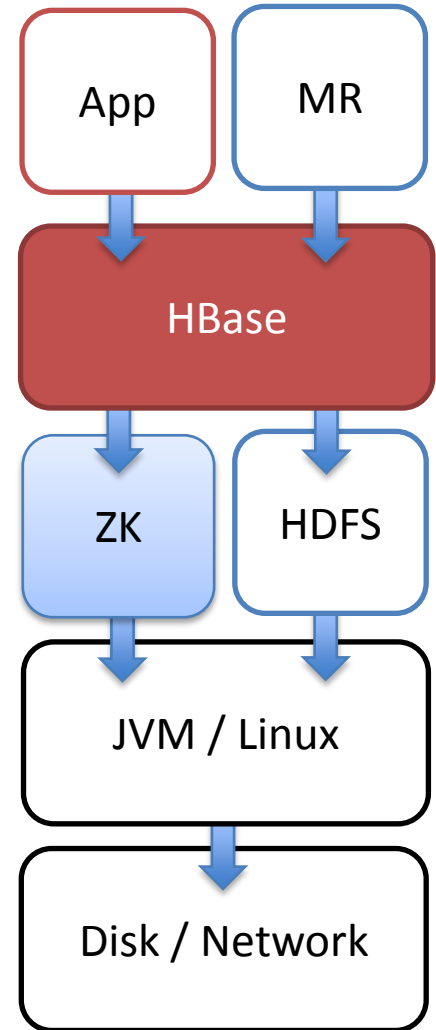
Connection Reset

WARN - Session <id> for server <server id>, unexpected error, closing socket connection and attempting reconnect java.io.IOException: Connection reset by peer

What causes this?

- Running out of ZK connections

How can it be resolved?

- Manually close connections
- Fixed in HBASE-5466 and HBASE-4773

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Running out of DN Threads & File Descriptors

INFO hdfs.DFSClient: Could not obtain block <blk id> from any node: java.io.IOException: No live nodes contain current block.
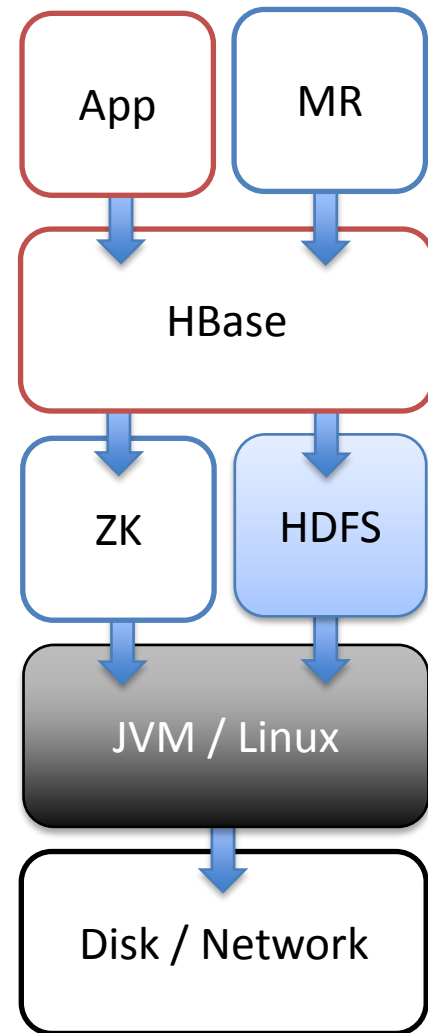
ERROR java.io.IOException: Too many open files

What causes this?

- HBase likes to keep data files open

How can it be resolved?

- Increase dfs.datanode.max.xcievers to 4096
- Increase /etc/security/limits.conf
  - hbase - nofile 32768

```
App        MR
    ↓       ↓
    HBase
    ↓       ↓
   ZK      HDFS
    ↓       ↓
    JVM / Linux
         ↓
    Disk / Network
```
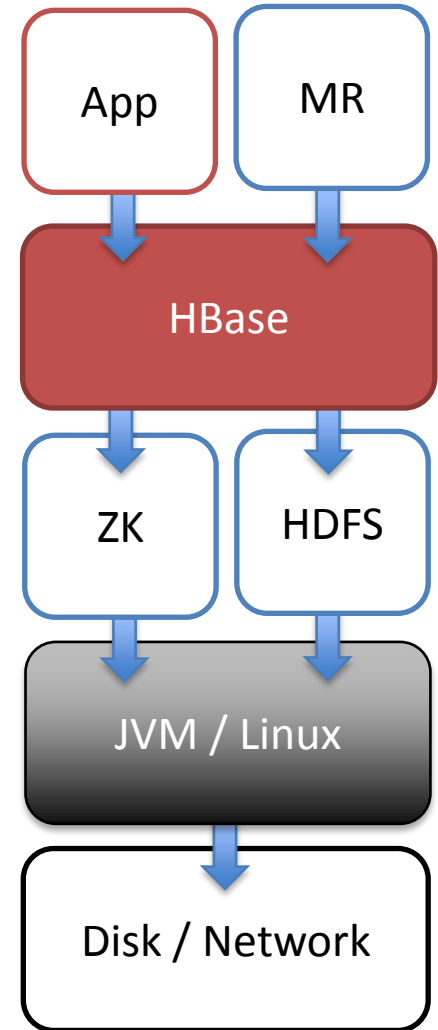
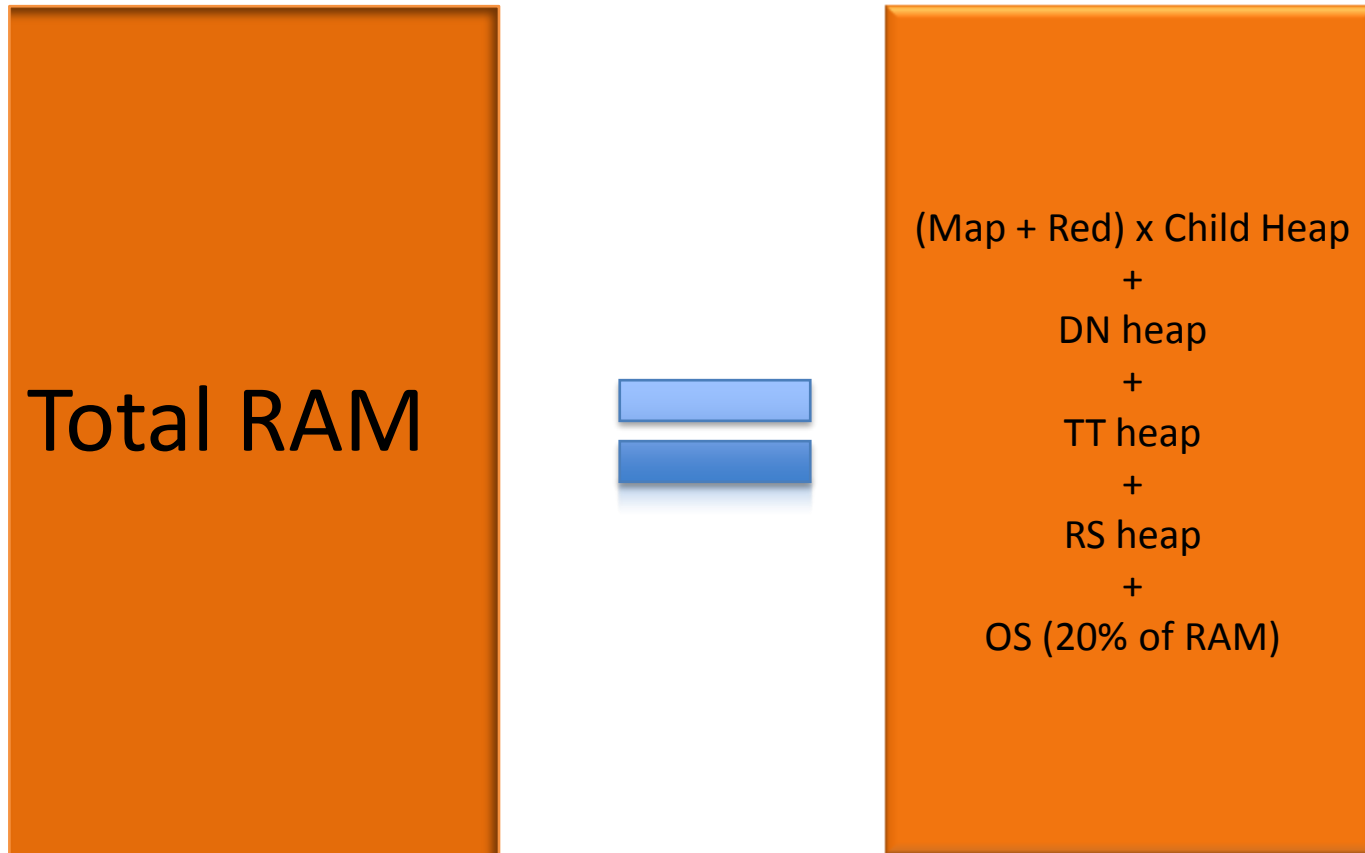cloudera

"Long Garbage Collecting Pause"

WARN org.apache.hadoop.hbase.util.Sleeper:
We slept 19118ms instead of 1000ms, this is
likely due to a long garbage collecting pause and
it's usually bad

How can it be resolved?

- zoo.cfg: maxSessionTimeout=180000
  hbase-site.xml: zookeeper.session.timeout=180000
- Oversubscribed if MR & HBase are co-located

App MR

HBase

ZK HDFS

JVM / Linux

Disk / Network

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Heap Allocation Per Node

Total RAM

=

(Map + Red) x Child Heap
+
DN heap
+
TT heap
+
RS heap
+
OS (20% of RAM)

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The HBase Triage: Fixes for acute HBase pains

- Severe Pain

- Complete Unconsciousness
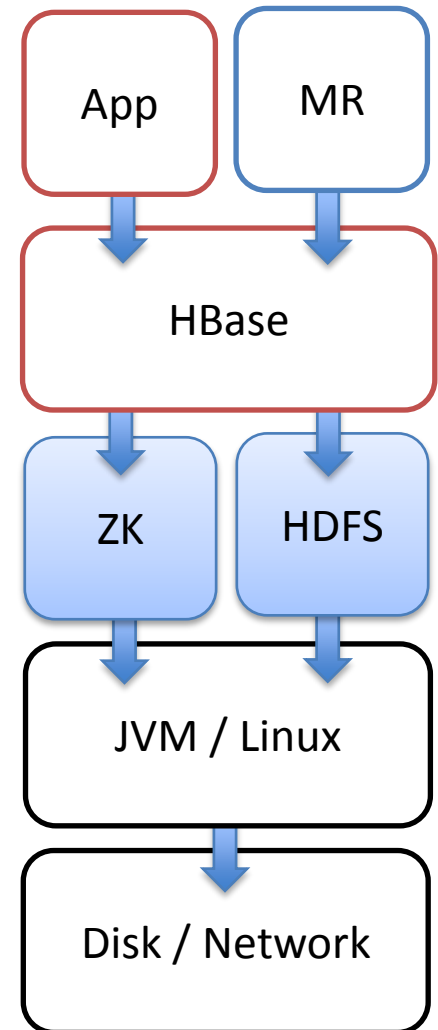
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ZK can't start & HBase hangs

INFO org.apache.hadoop.hdfs.DFSClient: Could not complete file <name> retrying…

What causes this?

- High dfs.replication.min causes HBase hang - can't close file until created all replicas

How can it be resolved?

- Remove dfs.replication.min
- Temp increase dfs.balance.bandwidthPerSec
- Fixed in HDFS-2936
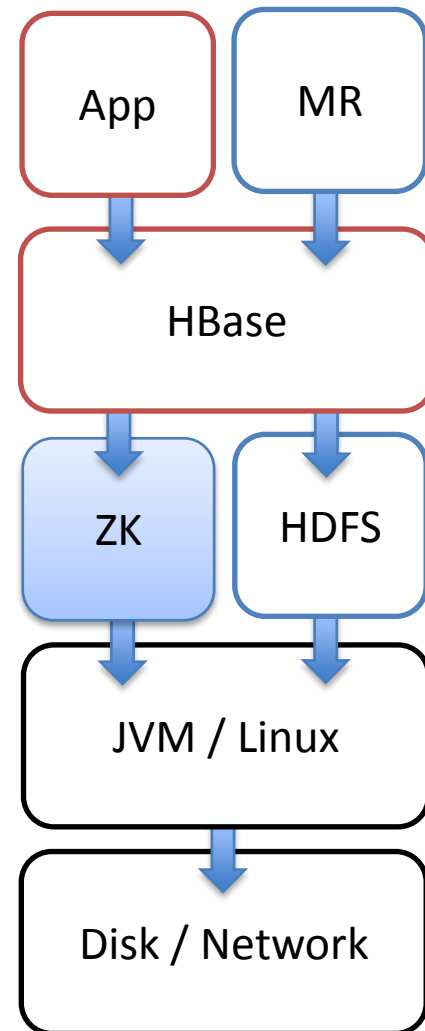
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Unable to Load Database

FATAL
org.apache.zookeeper.server.quorum.QuorumPeer: Unable to load database on disk

What causes this?

- ZK data directories filled up

How can it be resolved?

- Wipe out /var/zookeeper/version-2
- Run zkCleanup.sh script via cron

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Downed HBase Master and RegionServers

WARN
org.apache.zookeeper.server.quorum.Learner:
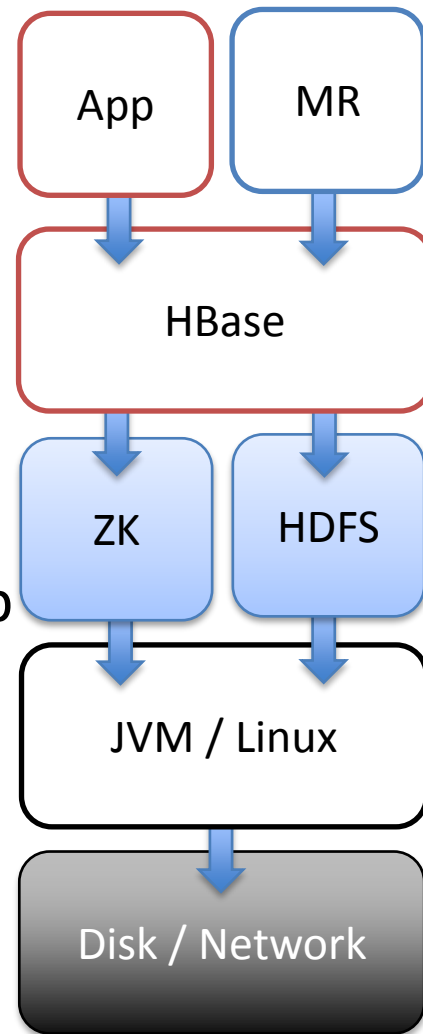Exception when following the leader
java.net.SocketTimeoutException: Read timed out

What causes this?

- Session Timeout + Session Expiration = NW Prob

How can it be resolved?

- Monitor network (e.g. ifconfig)
- Run ≥ 3 ZK servers (majority rules)

The HBase Triage: Fixes for acute HBase pains

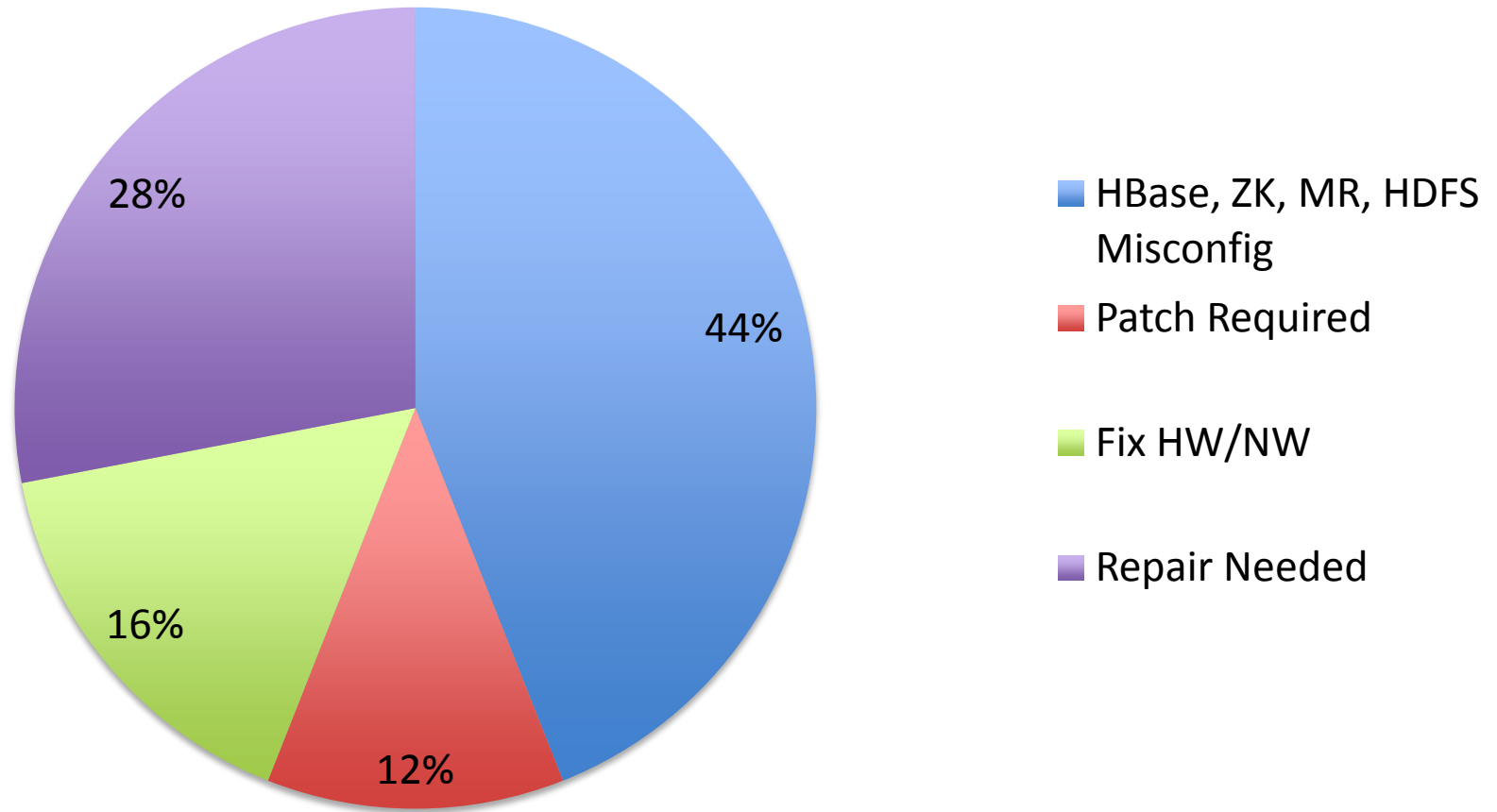- Severe Pain

- Complete Unconsciousness

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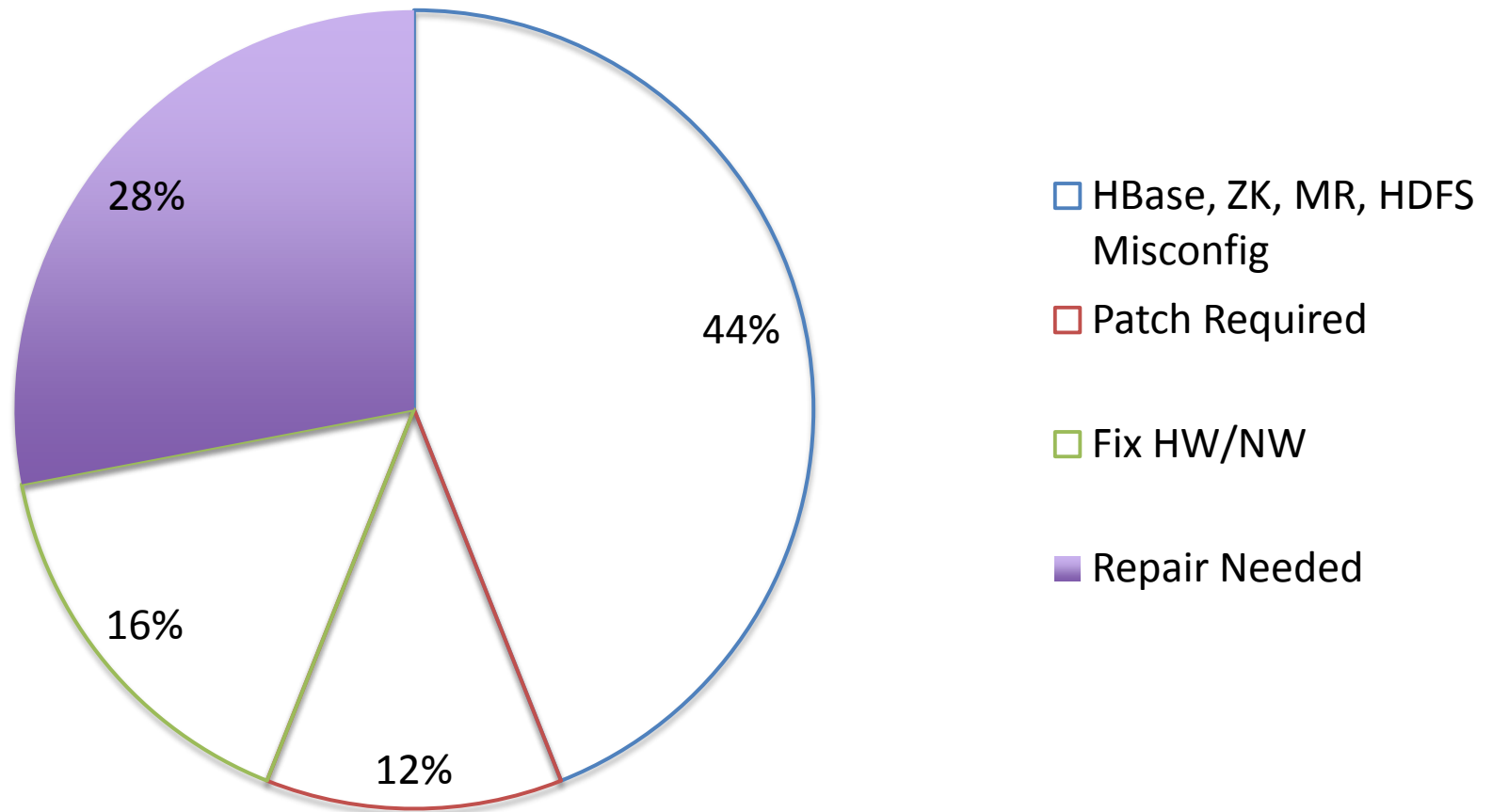- The HBase Surgery:
  - Repairing a Corrupted HBase

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"To the operating room, please"

HBase Support Tickets

Legend:
- HBase, ZK, MR, HDFS Misconfig — 44%
- Patch Required — 12%
- Fix HW/NW — 16%
- Repair Needed — 28%

HBase Support Tickets

- HBase, ZK, MR, HDFS Misconfig — 44%
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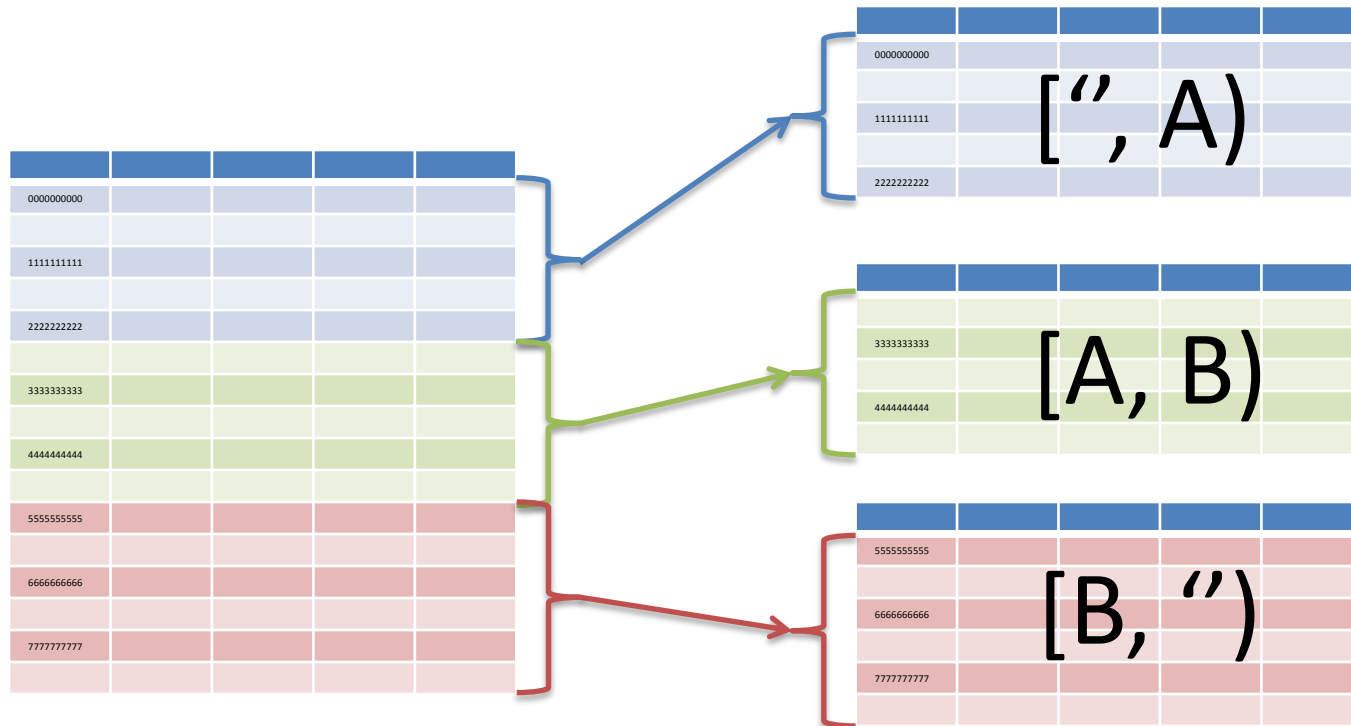- Repair Needed — 28%

Detecting internal problems with hbck

- HBase since 0.90 has included a tool for scanning an HBase instance's internals to find corruptions.

```
hbase hbck
```

```
hbase hbck -details
```
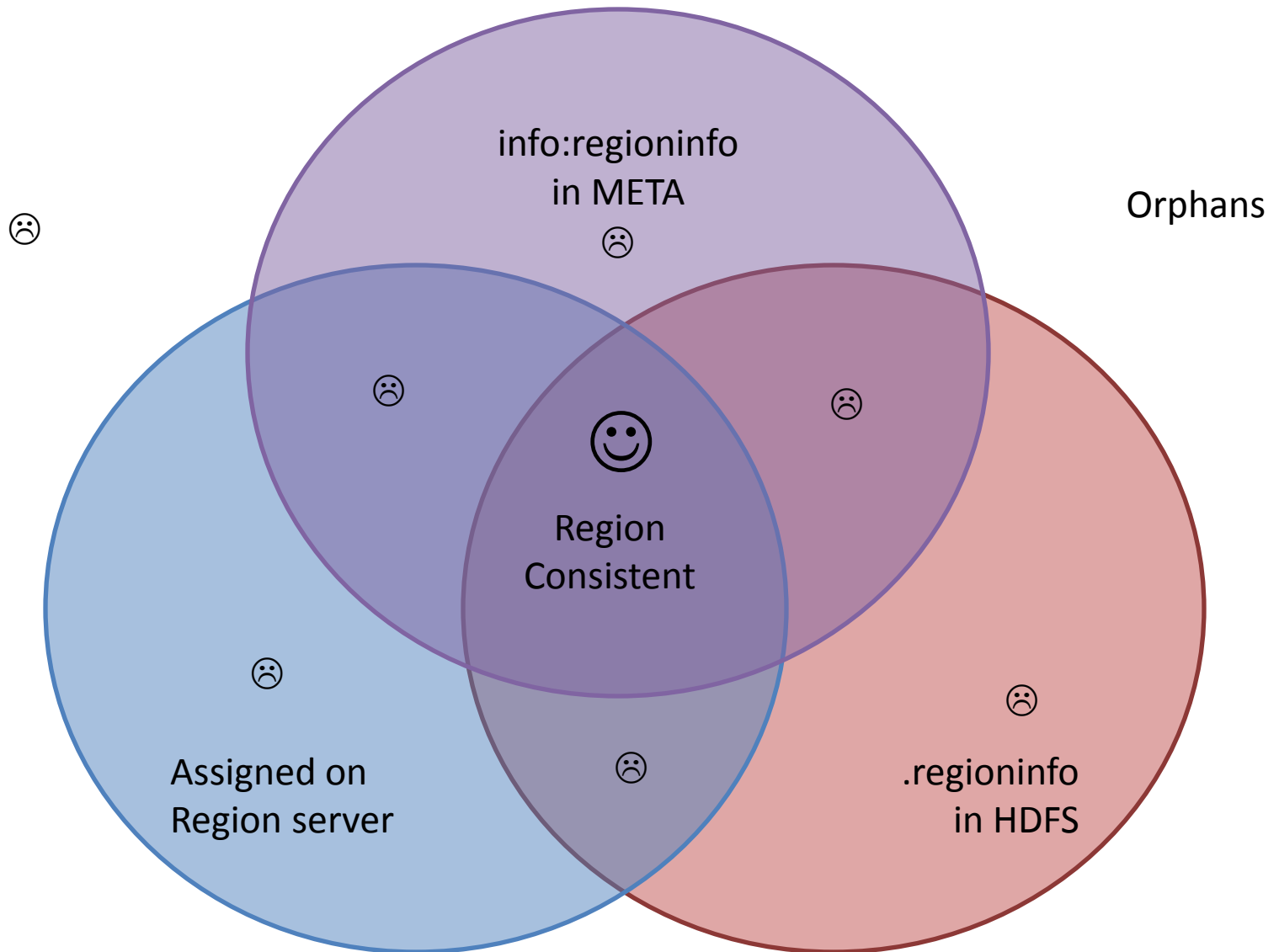
Tables are sharded into regions

[", A)

[A, B)

[B, ")

Invariants: Maintain **table integrity** and **region consistency** !

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Table Integrity Invariants

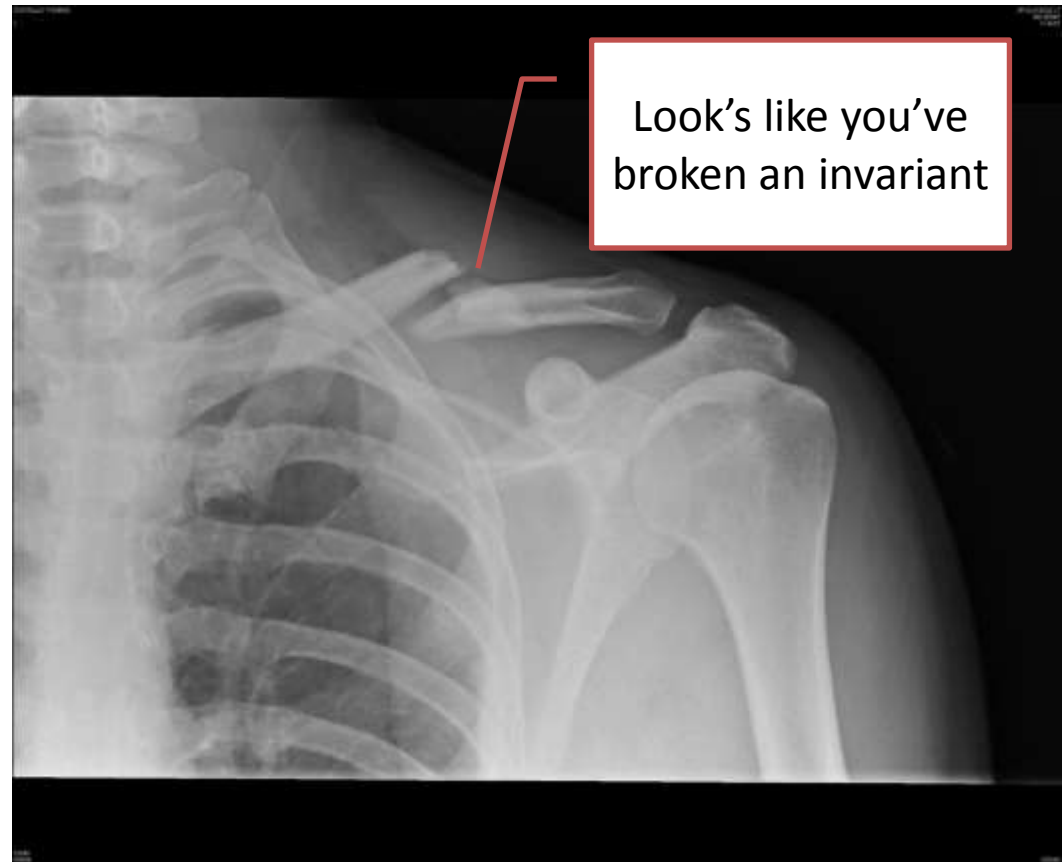| |
|---|
| [' ',A) |
| [A,B) |
| [B, C) |
| [C, D) |
| [D, E) |
| [E, F) |
| [F, G) |
| [G, ' ') |

- Every key shall get assigned to a single region.
- Table Regions shall:
  - Cover the entire range of possible keys,
  - from the absolute start ('')
  - to the absolute end (unfortunately, also '').

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Region Consistency Invariants

info:regioninfo
in META
☹

Orphans

☹

☹

☹

☺

Region
Consistent

☹

Assigned on
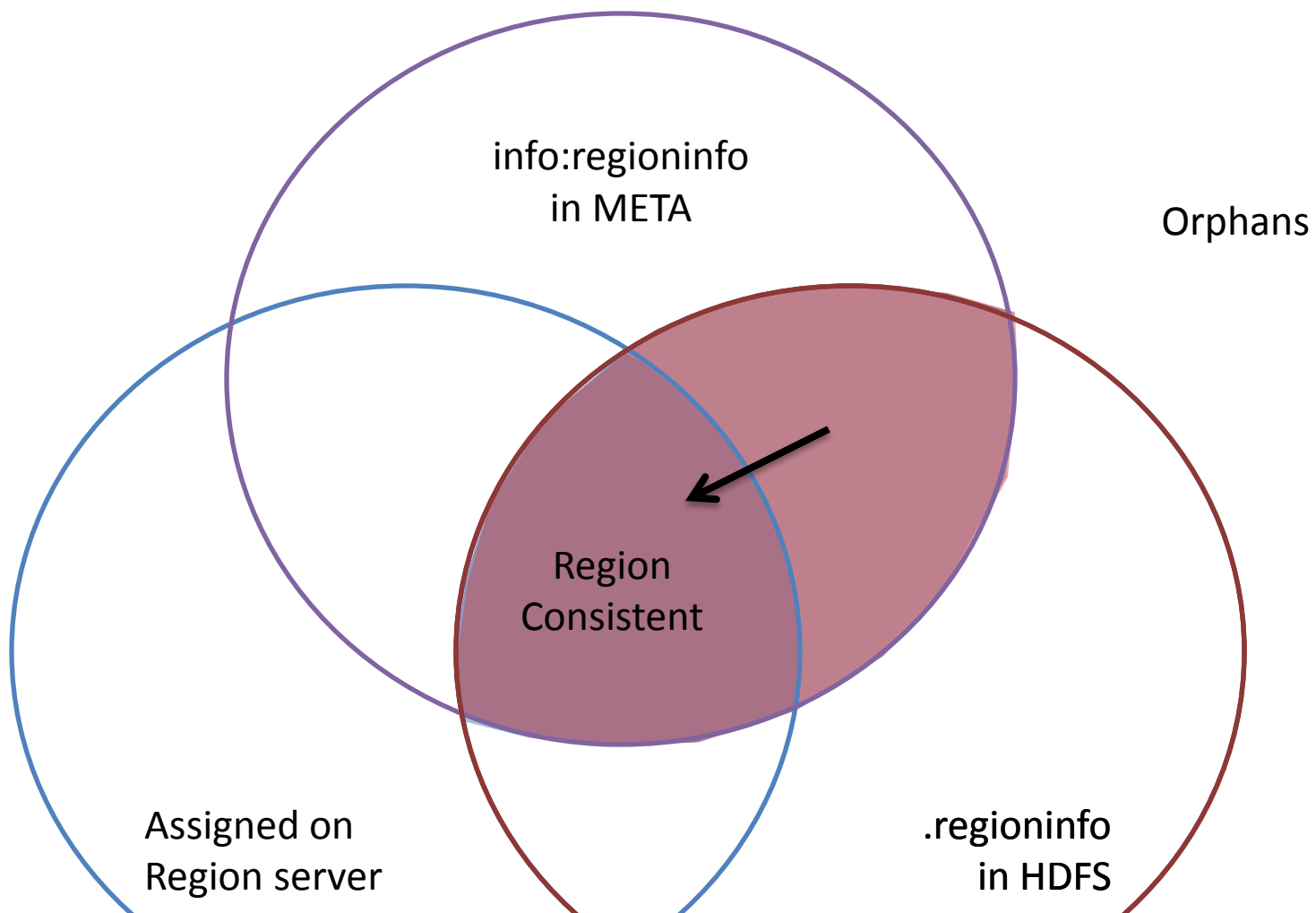Region server

☹

.regioninfo
in HDFS

Repairing internal problems with hbck

- Newer and upcoming versions of HBase include an hbck that can **fix** internal problem as well as detect.
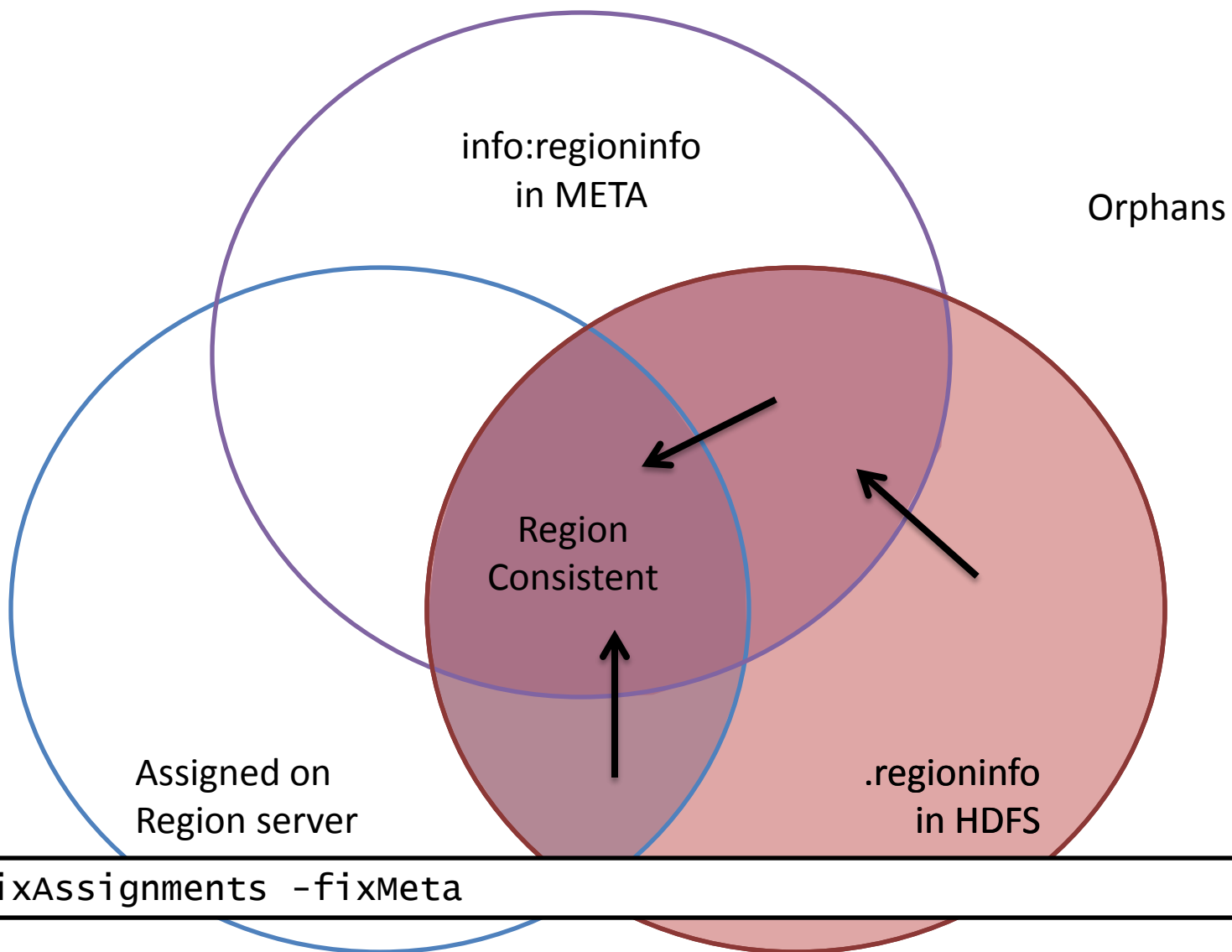 - 0.90.7
  - 0.92.2
  - 0.94.0
  - CDH3u4+
  - CDH4b2+

Look's like you've broken an invariant

Bad region assignment

info:regioninfo
in META

Orphans

Region
Consistent

Assigned on
Region server

.regioninfo
in HDFS

```
hbck -fix (0.90.x)
hbck -fixAssignments (0.90.7+, 0.92.2+, 0.94+)
```

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Region not in META

info:regioninfo in META

Orphans

Region Consistent

Assigned on Region server

.regioninfo in HDFS

```
hbck –fixAssignments -fixMeta
```

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Regioninfo not in HDFS

info:regioninfo
in META

Orphans

Region
Consistent

Assigned on
Region server

.regioninfo
in HDFS

```
hbck –fixAssignments -fixMeta
```
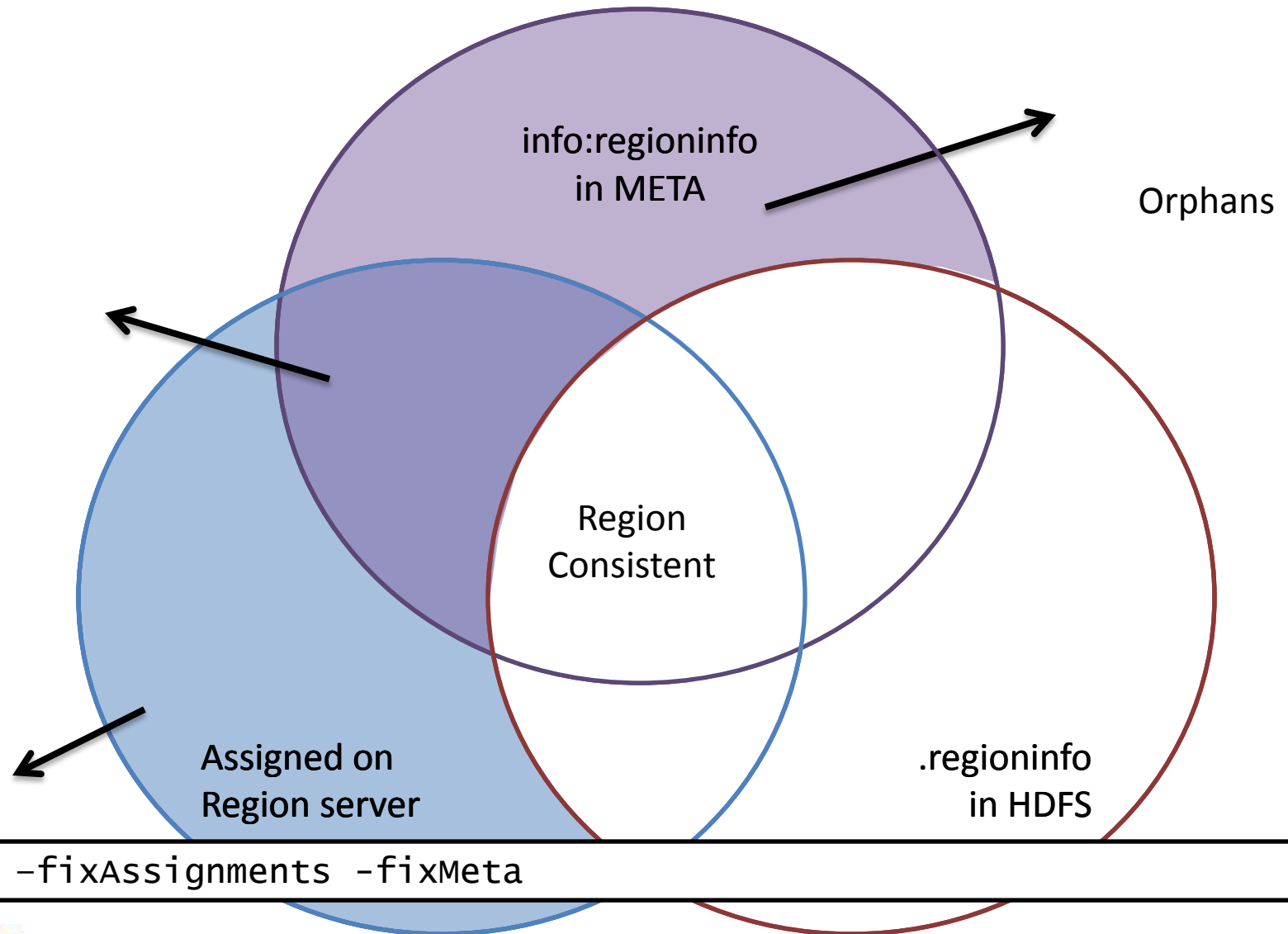
Table Regions must not have holes

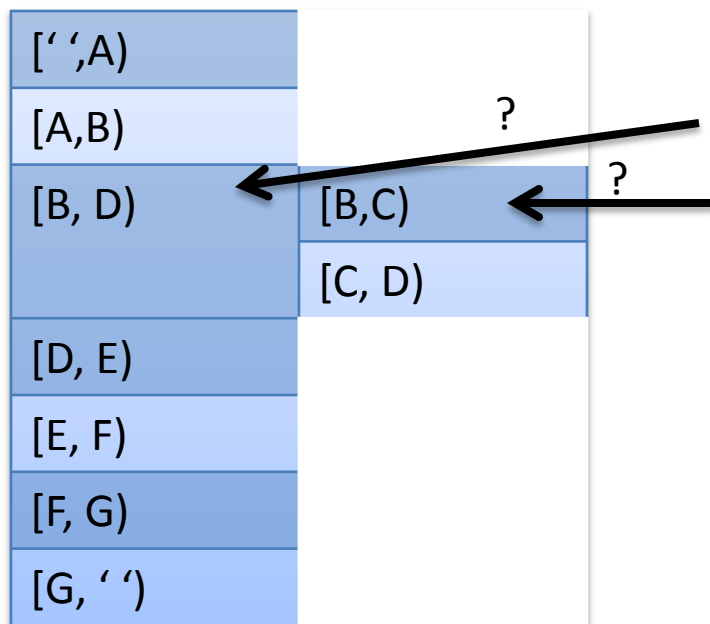| |
|---|
| [' ',A) |
| [A,B) |
| [B, C) |
| |
| [D, E) |
| [E, F) |
| [F, G) |
| [G, ' ') |

? ⟵
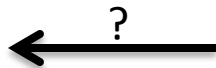
- Where to I put row key "CRUD"?
- Where is region [C,D)?

- Repair:
  - Find the orphan and adopt it.
  - Fabricate a new region to fill the hole

```
# NOTE! HBase should be idle (no get/put/split/compacts)
hbck –fixHdfsHoles –fixHdfsOrphans –fixAssignments –fixMeta
```
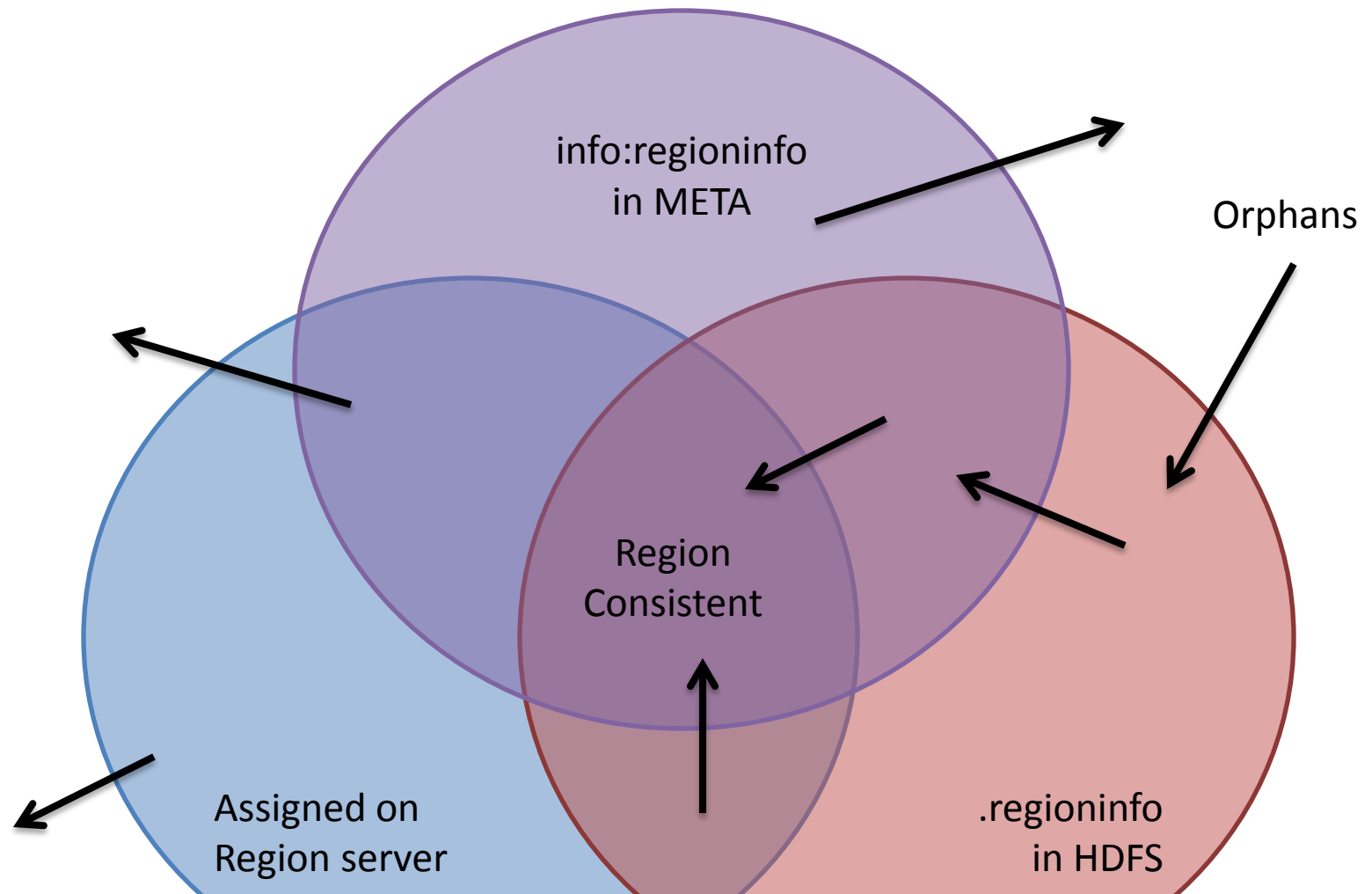
Table Regions must not overlap

[' ',A)	
[A,B)	?
[B, D)	[B,C) ?
	[C, D)
[D, E)	
[E, F)	
[F, G)	
[G, ' ')	

- Hm.. Which region should "BAD" go?
- Is it [B, D) or is it [B,C)?
- Likely due to a bad split.
- Repair:
  - Merge regions or,
  - Sideline and bulk load

```
# NOTE! HBase should be idle (no get/put/split/compacts)
hbck –fixHdfsOverlaps –fixAssignments –fixMeta
```

Consistency problem summary

info:regioninfo
in META

Orphans

Region
Consistent

Assigned on
Region server

.regioninfo
in HDFS

```
hbck –fixAssignments –fixMeta –fixHdfsHoles –fixHdfsOrphans –
fixHdfsOverlaps
```

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Investigating further

- HFile – examine contents of HFiles

- Hlog – examine contents of HLog file

- OfflineMetaRepair – Rebuild meta table from file system.

- Also, some scripts for manual repairs: https://github.com/jmhsieh/hbase-repair-scripts

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Questions?