HDFS Installation and Shell

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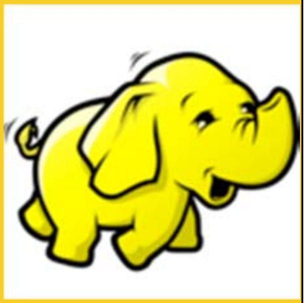

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Agenda

- Pseudo-Distributed Installation
- Namenode Safemode
- Secondary Namenode
- Hadoop Filesystem Shell

Installation - Prerequisites

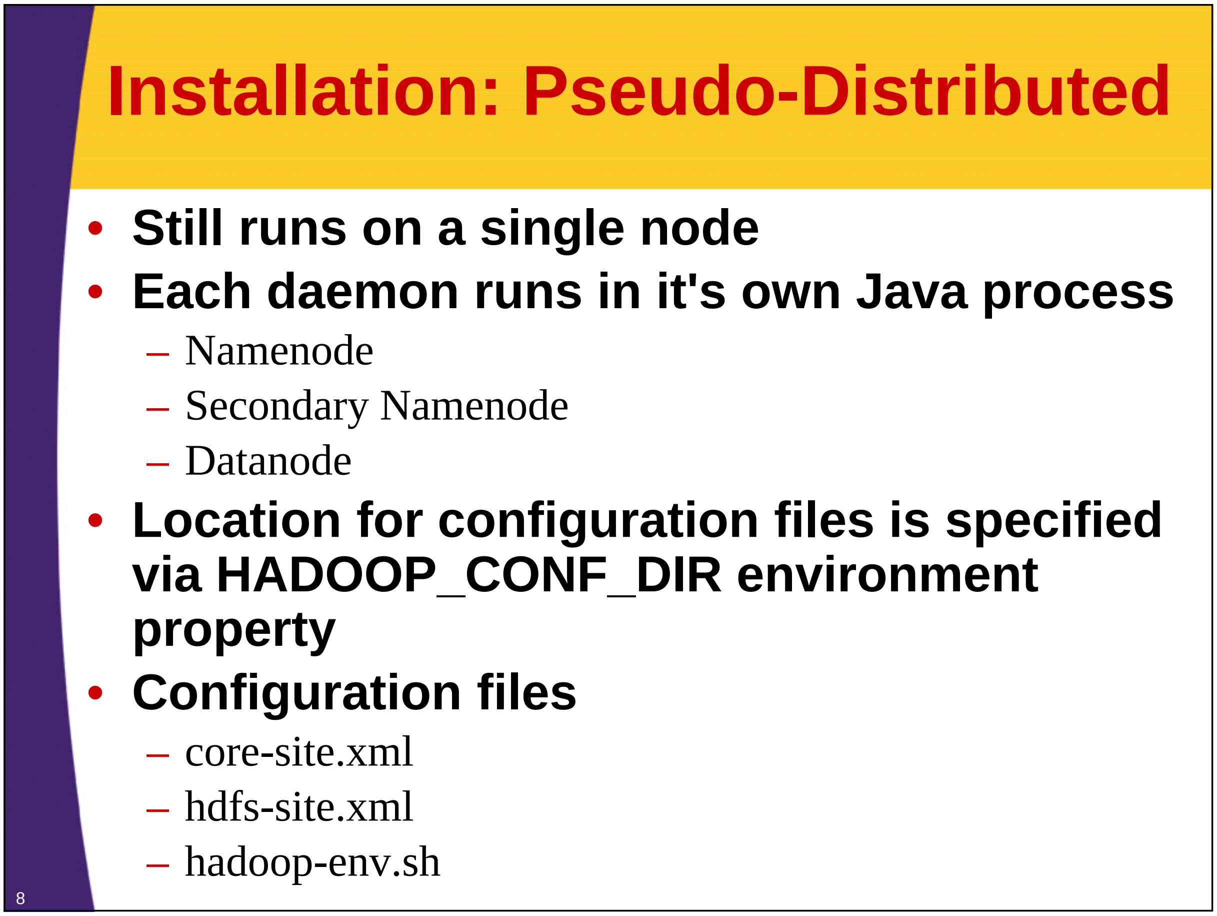
- JavaTM 1.6.x
  - From Oracle (previously Sun Microsystems)
- SSH installed, sshd must be running
  - Used by Hadoop scripts for management
- Cygwin for windows shell support

Installation

- **Three options**
  - Local (Standalone) Mode
  - Pseudo-Distributed Mode
  - Fully-Distributed Mode

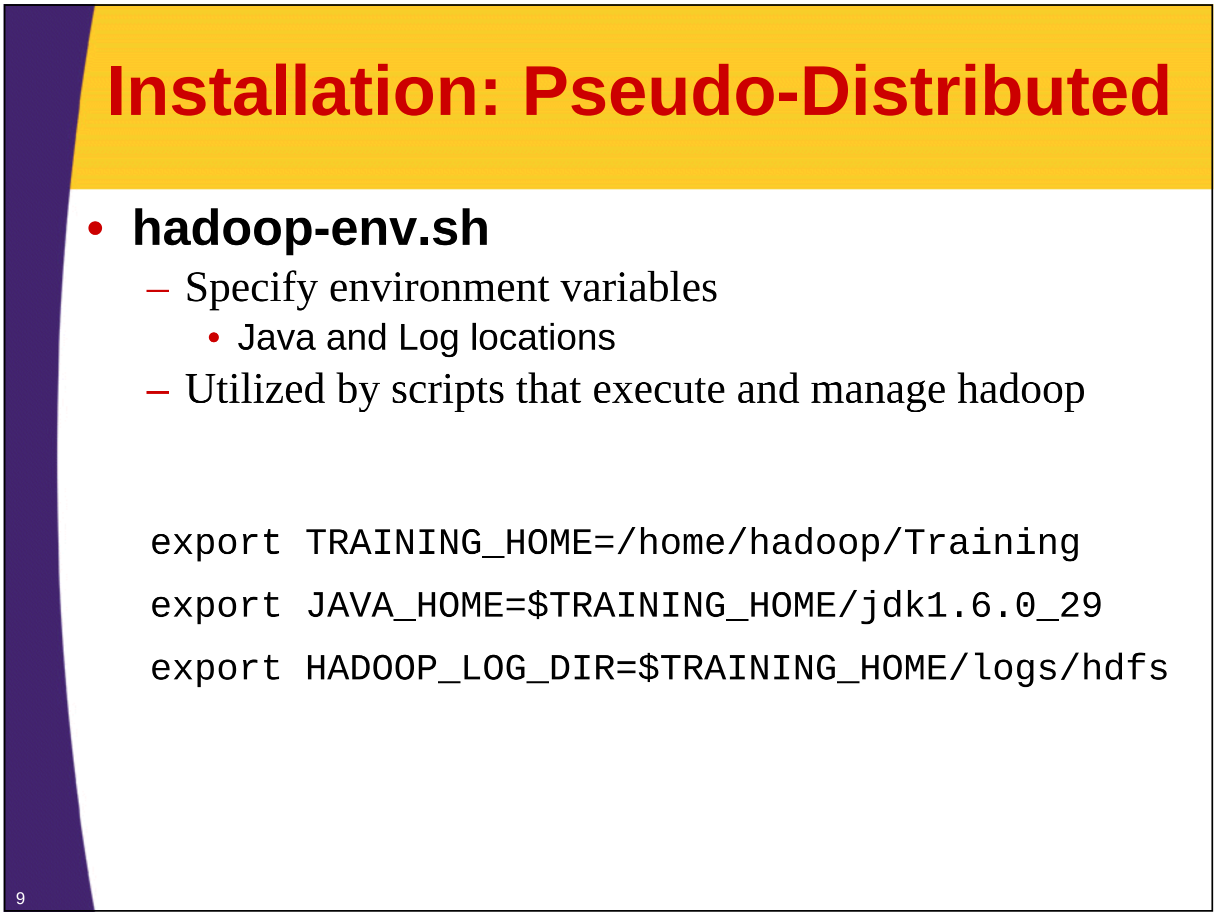
Installation: Local

- **Default configuration after the download**
- **Executes as a single Java process**
- **Works directly with local filesystem**
- **Useful for debugging**
- **Simple example, list all the files under /**
  - $ cd <hadoop_install>/bin
  - $ hdfs dfs -ls /



Installation: Pseudo-Distributed

- **Still runs on a single node**
- **Each daemon runs in it's own Java process**
  - Namenode
  - Secondary Namenode
  - Datanode
- **Location for configuration files is specified via HADOOP_CONF_DIR environment property**
- **Configuration files**
  - core-site.xml
  - hdfs-site.xml
  - hadoop-env.sh



Installation: Pseudo-Distributed

- **hadoop-env.sh**
  - Specify environment variables
    - Java and Log locations
  - Utilized by scripts that execute and manage hadoop

```
export TRAINING_HOME=/home/hadoop/Training
export JAVA_HOME=$TRAINING_HOME/jdk1.6.0_29
export HADOOP_LOG_DIR=$TRAINING_HOME/logs/hdfs
```

Installation: Pseudo-Distributed

- **$HADOOP_CONF_DIR/core-site.xml**
  - Configurations for core of Hadoop, for example IO properties
- **Specify location of Namenode**

```
<property>
  <name>fs.default.name</name>
  <value>hdfs://localhost:8020</value>
  <description>NameNode URI</description>
</property>
```

Installation: Pseudo-Distributed

- **$HADOOP_CONF_DIR/hdfs-site.xml**
  - Configurations for Namenode, Datanode and Secondary Namenode daemons

```
<property>
  <name>dfs.namenode.name.dir</name>
  <value>/home/hadoop/Training/hadoop_work/data/name</value>
  <description>Path on the local filesystem where the
NameNode stores the namespace and transactions logs
persistently.</description>
</property>

<property>
  <name>dfs.datanode.data.dir</name>
  <value>/home/hadoop/Training/hadoop_work/data/data</value>
  <description>Comma separated list of paths on the local
filesystem of a Datanode where it should store its blocks.
</description>
</property>
```

Installation: Pseudo-Distributed

- **$HADOOP_CONF_DIR/hdfs-site.xml**

```
<property>
 <name>dfs.namenode.checkpoint.dir</name>
 <value>/home/hadoop/Training/hadoop_work/data/secondary_name</value>
 <description>Determines where on the local filesystem the DFS
secondary name node should store the temporary images to
merge. If this is a comma-delimited list of directories then
the image is replicated in all of the directories for
redundancy.
  </description>
</property>

<property>
    <name>dfs.replication</name>
    <value>1</value>
</property>
```

Installation: Pseudo-Distributed

- **$HADOOP_CONF_DIR/slaves**
  - Specifies which machines Datanodes will run on
  - One node per line

- **$HADOOP_CONF_DIR/masters**
  - Specifies which machines Secondary Namenode will run on
  - Misleading name

Installation: Pseudo-Distributed

- **Password-less SSH is required for Namenode to communicate with Datanodes**
- **In this case just to itself**
- **To test:**
  - $ ssh localhost
- **To set-up**
  - $ ssh-keygen -t dsa -P '' -f ~/.ssh/id_dsa
  - $ cat ~/.ssh/id_dsa.pub >> ~/.ssh/authorized_keys

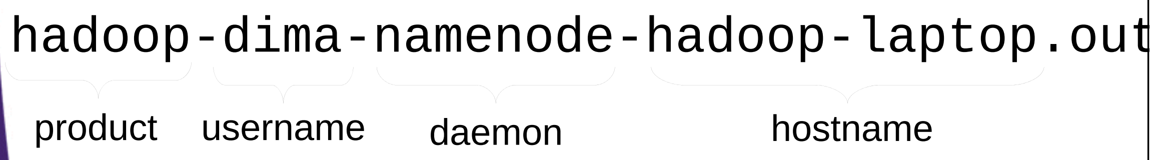
Installation: Pseudo-Distributed

- **Prepare filesystem for use by formatting**
  - $ hdfs namenode -format
- **Start the distributed filesystem**
  - $ cd <hadoop_install>/sbin
  - $ start-dfs.sh
- **start-dfs.sh prints the location of the logs**

```
$ ./start-dfs.sh
Starting namenodes on [localhost]
localhost: starting namenode, logging to /home/hadoop/Training/logs/hdfs/hadoop-hadoop-namenode-hadoop-laptop.out
localhost: 2012-07-17 22:17:17,054 INFO  namenode.NameNode
(StringUtils.java:startupShutdownMessage(594)) - STARTUP_MSG:
localhost: /************************************************************
localhost: STARTUP_MSG: Starting NameNode
...
```

Installation: logs

- **Each Hadoop daemon writes a log file:**
  - Namenode, Datanode, Secondary Namenode
  - Location of these logs are set in $HADOOP_CONF_DIR/hadoop-env.sh
    - export HADOOP_LOG_DIR=$TRAINING_HOME/logs/hdfs
- **Log naming convention:**



```
hadoop-dima-namenode-hadoop-laptop.out
```

Installation: logs

- **Log locations are set in `$HADOOP_CONF_DIR/hadoop-env.sh`**
  - Specified via $HADOOP_LOG_DIR property
  - Default is <install_dir>/logs
  - It's a good practice to configure log directory to reside away from the installation directory

```
export TRAINING_HOME=/home/hadoop/Training
export HADOOP_LOG_DIR=$TRAINING_HOME/logs/hdfs
```

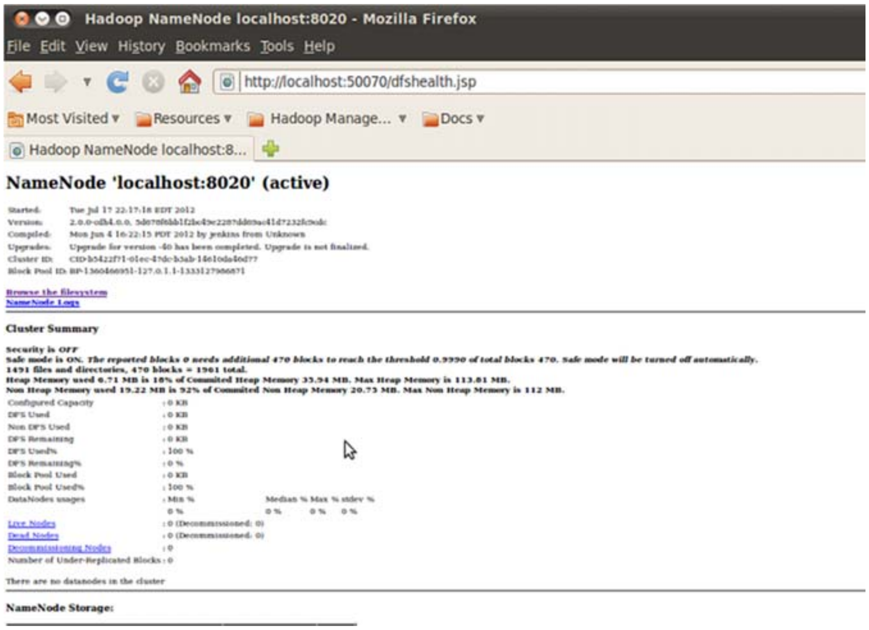
Management Web Interface

- **Namenode comes with web based management**
  - http://localhost:50070
- **Features**
  - Cluster status
  - View Namenode and Datanode logs
  - Browse HDFS
- **Can be configured for SSL (https:) based access**
- **Secondary Namenode also has web UI**
  - http://localhost:50090

Management Web Interface

- **Datanodes run management web server also**
- **Browsing Namenode will re-direct to Datanodes' Web Interface**
- **Firewall considerations**
  - Opening <namenode_host>:50070 in firewall is not enough
  - Must open up <datanode(s)_host>:50075 on every datanode host
  - Best scenario is to open the browser behind firewall
    - SSH tunneling, Virtual Network Computing (VNC), X11, etc..
  - Can be SSL enabled

Management Web Interface


Hadoop NameNode localhost:8020 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost:50070/dfshealth.jsp
Most Visited ▾
Resources ▾
Hadoop Manage... ▾
Docs ▾
Hadoop NameNode localhost:8...

NameNode 'localhost:8020' (active)

Started:	Tue Jul 17 22:17:18 EDT 2012
Version:	2.0.0-cdh4.0.0, 5d678f6bb1f2bc49e2287dd69ac41d7232fc9cdc
Compiled:	Mon Jun 4 16:22:15 PDT 2012 by jenkins from Unknown
Upgrades:	Upgrade for version -40 has been completed. Upgrade is not finalized.
Cluster ID:	CID-b5422f71-01ec-47dc-b3ab-14610da46d77
Block Pool ID:	BP-1360466951-127.0.1.1-1333127966871

Browse the filesystem
NameNode Logs

Cluster Summary

Security is *OFF*
Safe mode is ON. *The reported blocks 0 needs additional 470 blocks to reach the threshold 0.9990 of total blocks 470. Safe mode will be turned off automatically.*
1491 files and directories, 470 blocks = 1961 total.
Heap Memory used 6.71 MB is 18% of Commited Heap Memory 33.94 MB. Max Heap Memory is 113.81 MB.
Non Heap Memory used 19.22 MB is 92% of Commited Non Heap Memory 20.73 MB. Max Non Heap Memory is 112 MB.

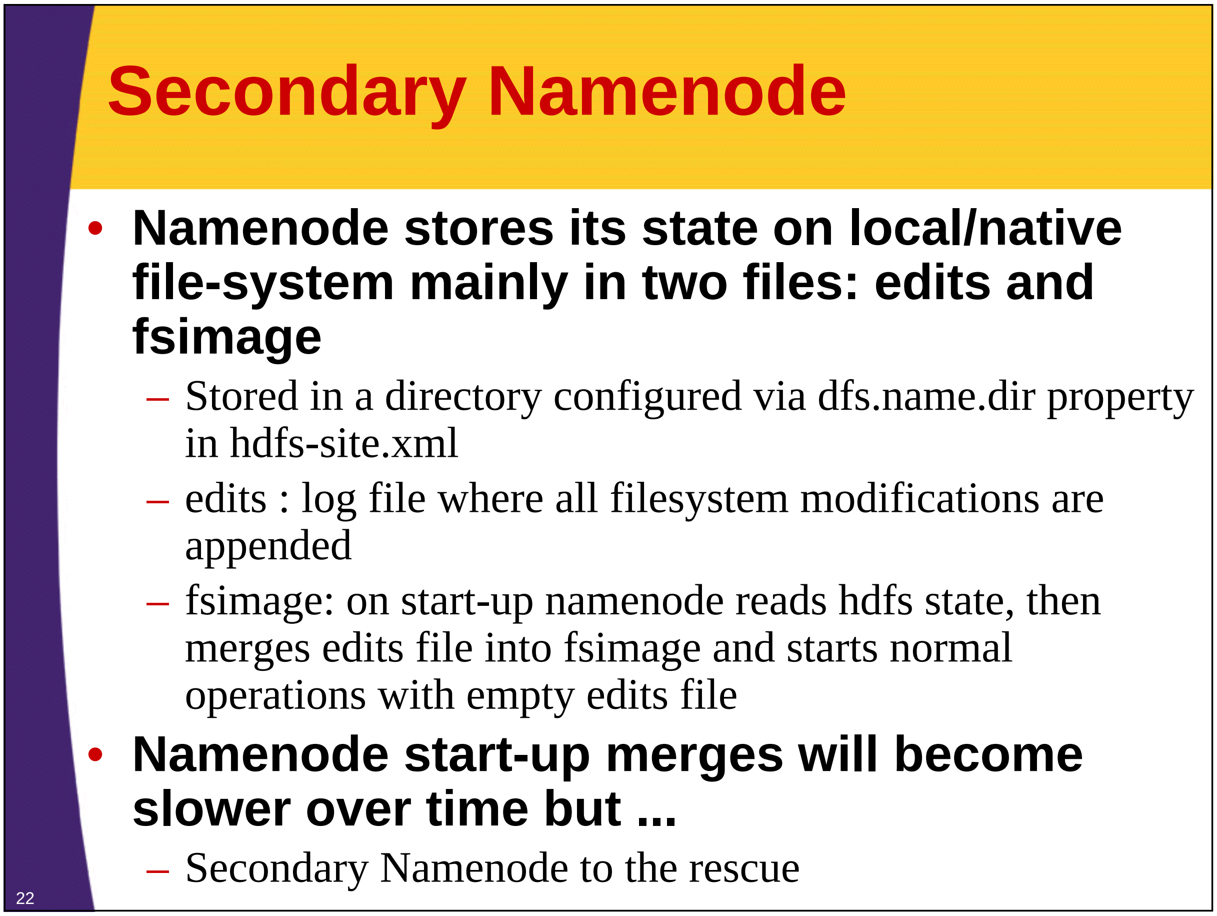
Configured Capacity	: 0 KB				
DFS Used	: 0 KB				
Non DFS Used	: 0 KB				
DFS Remaining	: 0 KB				
DFS Used%	: 100 %				
DFS Remaining%	: 0 %				
Block Pool Used	: 0 KB				
Block Pool Used%	: 100 %				
DataNodes usages	: Min %	Median %	Max %	stdev %	
	0 %	0 %	0 %	0 %	
Live Nodes	: 0 (Decommissioned: 0)				
Dead Nodes	: 0 (Decommissioned: 0)				
Decommissioning Nodes	: 0				
Number of Under-Replicated Blocks	: 0				

There are no datanodes in the cluster

NameNode Storage:

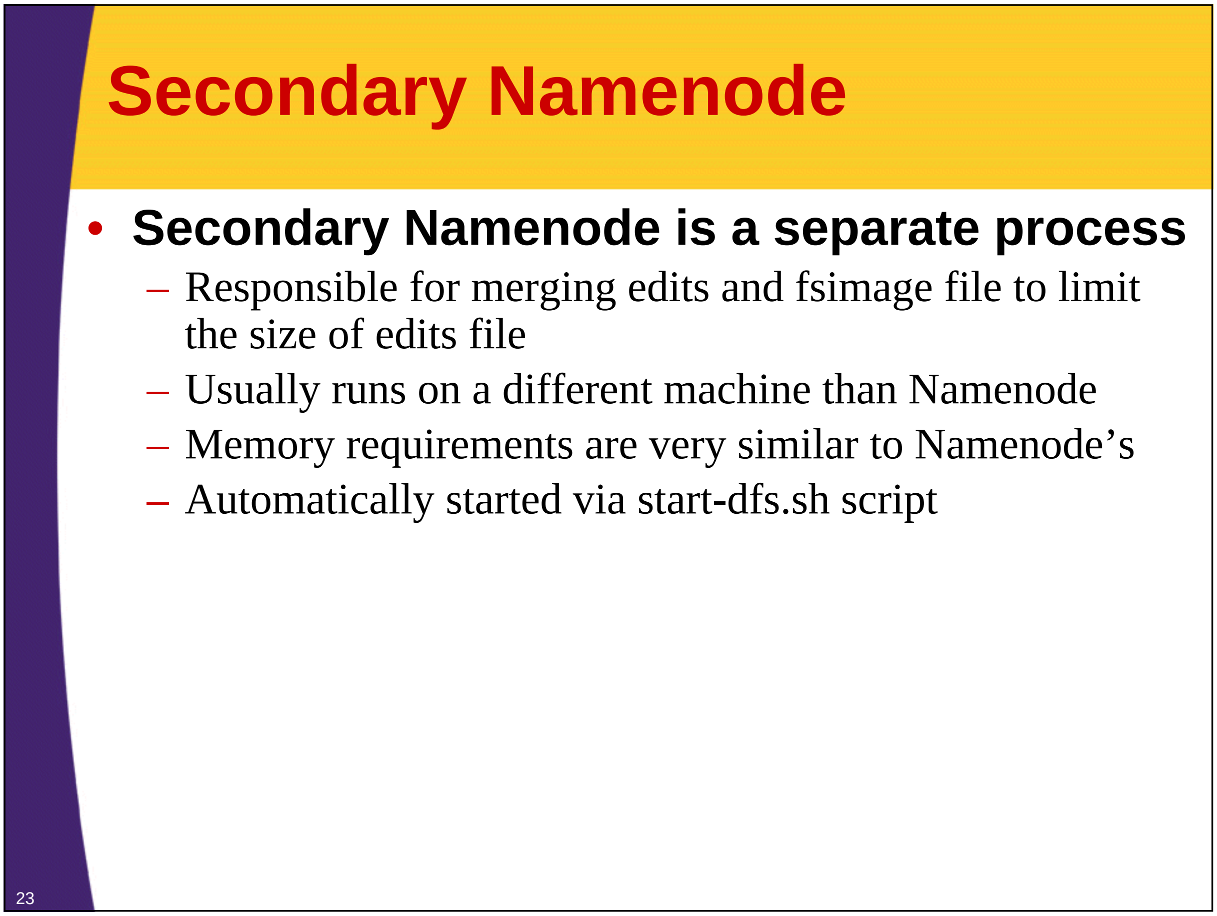
Namenode's Safemode

- **HDFS cluster read-only mode**
- **Modifications to filesystem and blocks are not allowed**
- **Happens on start-up**
  – Loads file system state from fsimage and edits-log files
  – Waits for Datanodes to come up to avoid over-replication
- **Namenode's Web Interface reports safemode status**
- **Could be placed in safemode explicitly**
  – for upgrades, maintenance, backups, etc....



Secondary Namenode

- **Namenode stores its state on local/native file-system mainly in two files: edits and fsimage**
  - Stored in a directory configured via dfs.name.dir property in hdfs-site.xml
  - edits : log file where all filesystem modifications are appended
  - fsimage: on start-up namenode reads hdfs state, then merges edits file into fsimage and starts normal operations with empty edits file
- **Namenode start-up merges will become slower over time but ...**
  - Secondary Namenode to the rescue



Secondary Namenode

- **Secondary Namenode is a separate process**
  - Responsible for merging edits and fsimage file to limit the size of edits file
  - Usually runs on a different machine than Namenode
  - Memory requirements are very similar to Namenode's
  - Automatically started via start-dfs.sh script

Secondary Namenode

- **Checkpoint is kicked off by two properties in hdfs-site.xml**
  - **fs.checkpoint.period**: maximum time period between two checkpoints
    - Default is 1 hour
    - Specified in seconds (3600)
  - **fs.checkpoint.size**: when the size of the edits file exceeds this threshold a checkpoint is kicked off
    - Default is 64 MB
    - Specified in bytes (67108864)

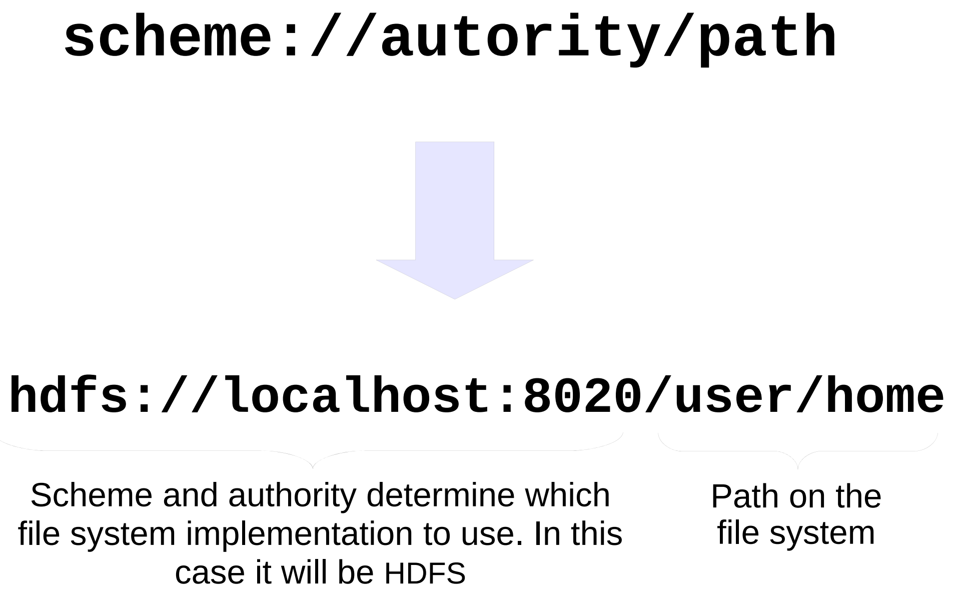
Secondary Namenode

- **Secondary Namenode uses the same directory structure as Namenode**
  - This checkpoint may be imported if Namenode's image is lost
- **Secondary Namenode is NOT**
  - Fail-over for Namenode
  - Doesn't provide high availability
  - Doesn't improve Namenode's performance

Shell Commands

- **Interact with FileSystem by executing shell-like commands**
- **Usage: $hdfs dfs -<command> -<option> <URI>**
  - Example $hdfs dfs -ls /
- **URI usage:**
  - HDFS: $hdfs dfs -ls hdfs://localhost/to/path/dir
  - Local: $hdfs dfs -ls file:///to/path/file3
  - Schema and namenode host is optional, default is used from the configuration
    - In core-site.xml - fs.default.name property

Hadoop URI



```
scheme://autority/path
```

```
hdfs://localhost:8020/user/home
```

Scheme and authority determine which file system implementation to use. In this case it will be HDFS

Path on the file system

Shell Commands

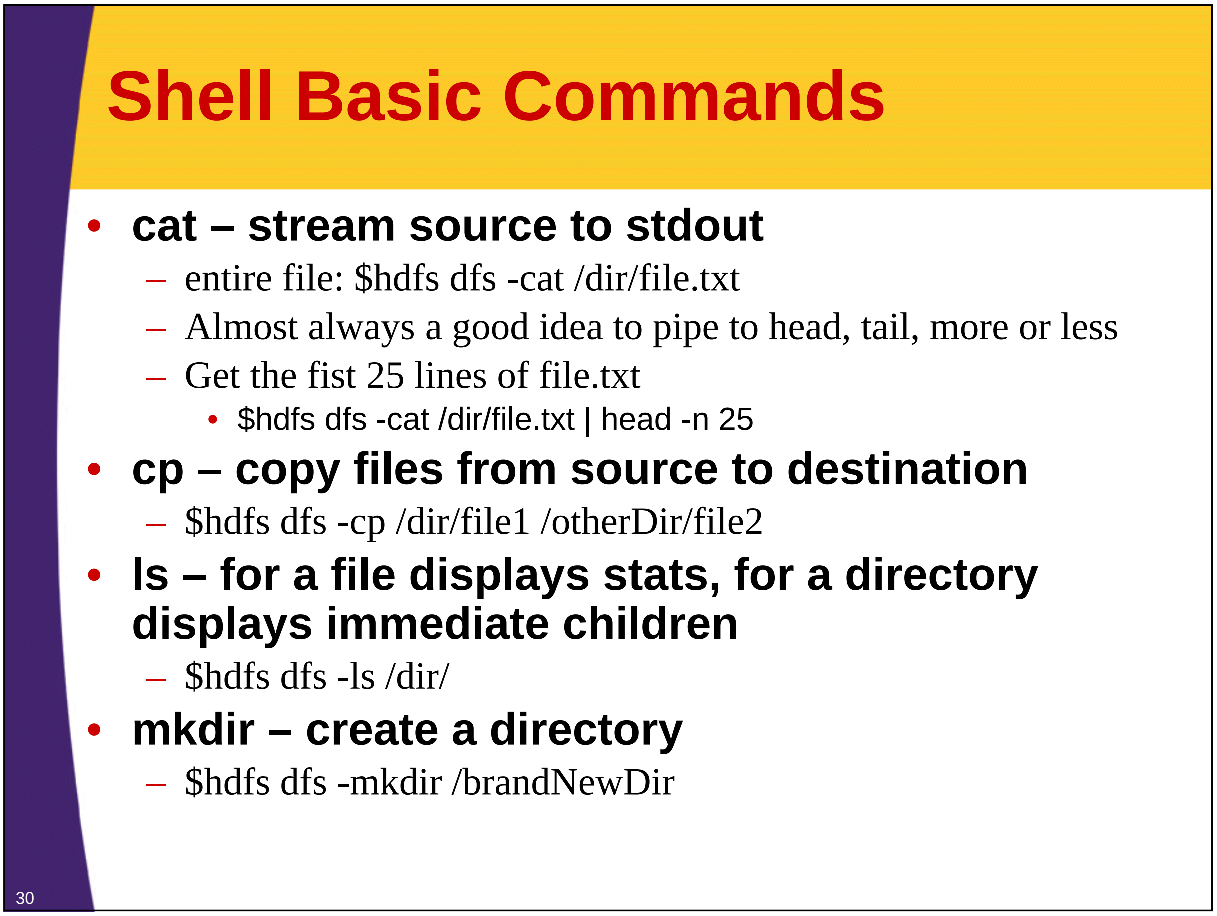
- **Most commands behave like UNIX commands**
  - – ls, cat, du, etc..
- **Supports HDFS specific operations**
  - – Ex: changing replication
- **List supported commands**
  - – $ hdfs dfs -help
- **Display detailed help for a command**
  - – $ hdfs dfs -help <command_name>

Shell Commands

- **Relative Path**
  - – Is always relative to user's home directory
  - – Home directory is at /user/<username>
- **Shell commands follow the same format:**

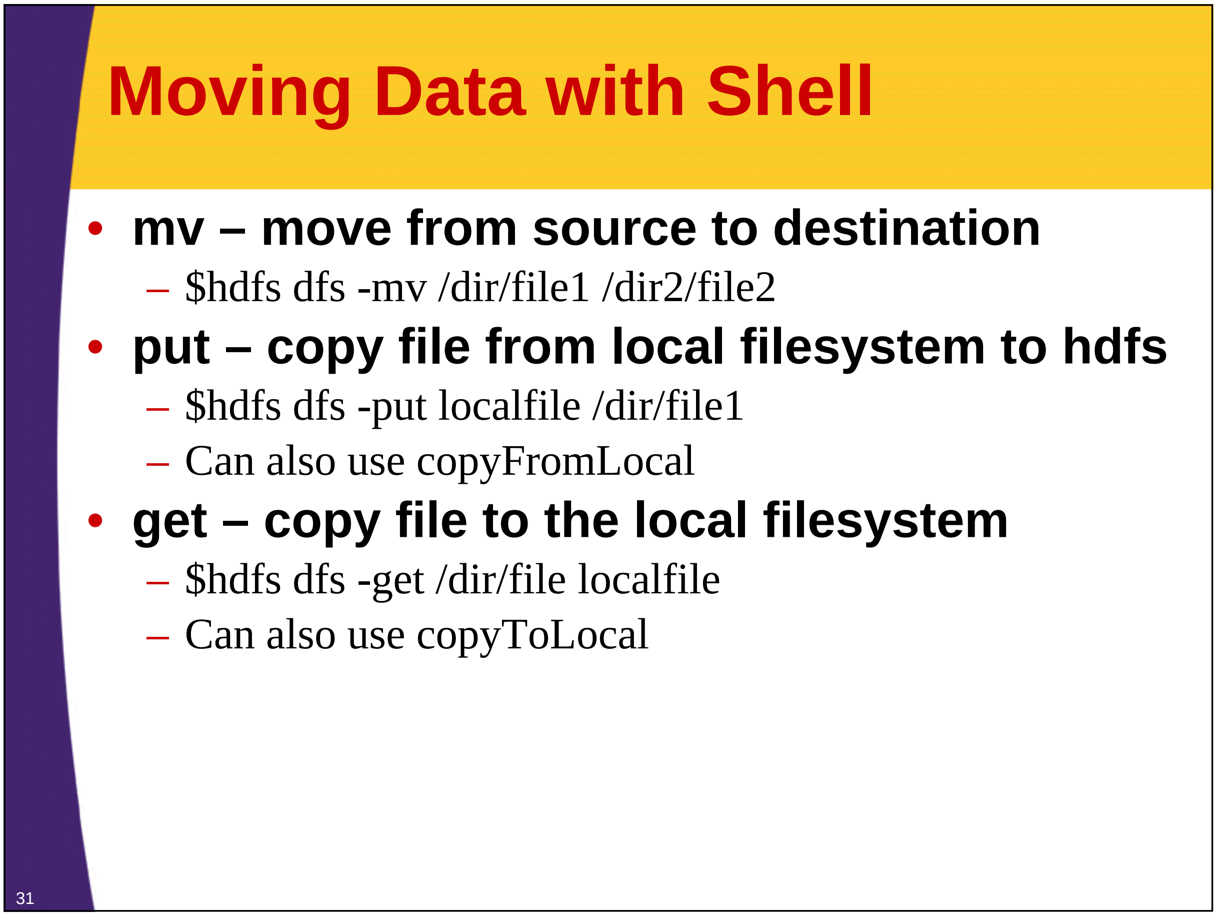
```
$ hdfs dfs -<command> -<option> <path>
```

- **For example:**
  - – $ hdfs dfs -rm -r /removeMe



Shell Basic Commands

- **cat – stream source to stdout**
  - entire file: $hdfs dfs -cat /dir/file.txt
  - Almost always a good idea to pipe to head, tail, more or less
  - Get the fist 25 lines of file.txt
    - $hdfs dfs -cat /dir/file.txt | head -n 25
- **cp – copy files from source to destination**
  - $hdfs dfs -cp /dir/file1 /otherDir/file2
- **ls – for a file displays stats, for a directory displays immediate children**
  - $hdfs dfs -ls /dir/
- **mkdir – create a directory**
  - $hdfs dfs -mkdir /brandNewDir



Moving Data with Shell

- **mv – move from source to destination**
  - $hdfs dfs -mv /dir/file1 /dir2/file2
- **put – copy file from local filesystem to hdfs**
  - $hdfs dfs -put localfile /dir/file1
  - Can also use copyFromLocal
- **get – copy file to the local filesystem**
  - $hdfs dfs -get /dir/file localfile
  - Can also use copyToLocal

Deleting Data with Shell

- **rm – delete files**
  - `$hdfs dfs -rm /dir/fileToDelete`
- **rm -r – delete directories recursively**
  - `$hdfs dfs -rm -r /dirWithStuff`

Filesystem Stats with Shell

- **du – displays length for each file/dir (in bytes)**
  - `$hdfs dfs -du /someDir/`
- **Add -h option to display in human-readable format instead of bytes**

  -
    ```
    $hdfs dfs -du -h /someDir
     206.3k  /someDir
    ```

Learn More About Shell

- **More commands**
  - tail, chmod, count, touchz, test, etc...
- **To learn more**

```
$hdfs dfs -help
$hdfs dfs -help <command>
```

- **For example:**
  - $ hdfs dfs -help rm

fsck Command

- **Check for inconsistencies**
- **Reports problems**
  - Missing blocks
  - Under-replicated blocks
- **Doesn't correct problems, just reports (unlike native fsck)**
  - Namenode attempts to automatically correct issues that fsck would report
- **$ hdfs fsck <path>**
  - Example : $ hdfs fsck /

HDFS Permissions

- **Limited to File permission**
  - Similar to POSIX model, each file/directory
  - has Read (r), Write (w) and Execute (x)
  - associated with owner, group or all others
- **Client's identity determined on host OS**
  - Username = \`whoami\`
  - Group = \`bash -c groups\`

HDFS Permissions

- **Authentication and Authorization with Kerberos**
  - Hadoop 0.20.20+
  - Earlier versions assumed private clouds with trusted users
  - Hadoop set-up with Kerberos is beyond the scope of this class
- **To learn about Hadoop and Kerberos**
  - http://hadoop.apache.org/common/docs/r0.23.0/hadoop-yarn/hadoop-yarn-site/ClusterSetup.html
  - CDH4 and Keberos:
    - https://ccp.cloudera.com/display/CDH4B2/Configuring+Hadoop+Security+in+CDH4#ConfiguringHadoopSecurityinCDH4-EnableHadoopsecurity
  - "Hadoop: The Definitive Guide" by Tom White

DFSAdmin Command

- **HDFS administrative operations**
  - $hdfs dfsadmin <command>
  - Example: $hdfs dfsadmin -report
- **-report : displays statistic about HDFS**
  - Some of these stats are available on Web Interface
- **-safemode : enter or leave safemode**
  - Maintenance, backups, upgrades, etc..

Rebalancer

- **Data on HDFS Clusters may not be uniformly spread between available Datanodes.**
  - Ex: New nodes will have significantly less data for some time
  - The location for new incoming blocks will be chosen based on status of Datanode topology, but the cluster doesn't automatically rebalance
- **Rebalancer is an administrative tool that analyzes block placement on the HDFS cluster and re-balances**
  - $ hdfs balancer

Wrap-Up

Summary

- **We learned about**
  - Pseudo-Distributed Installation
  - Namenode Safemode
  - Secondary Namenode
  - Hadoop FS Shell

Questions?

More info:
http://www.coreservlets.com/hadoop-tutorial/ – Hadoop programming tutorial
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