Hadoop architecture

IBM Information Management
Cloud Computing Center of Competence
IBM Canada Labs

Agenda

- Terminology review
- HDFS
- MapReduce
- Type of nodes
- Topology awareness

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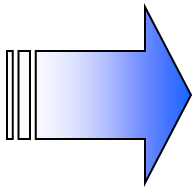

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Terminology review

Node 1

Terminology review

Node 1

Node 2

Terminology review

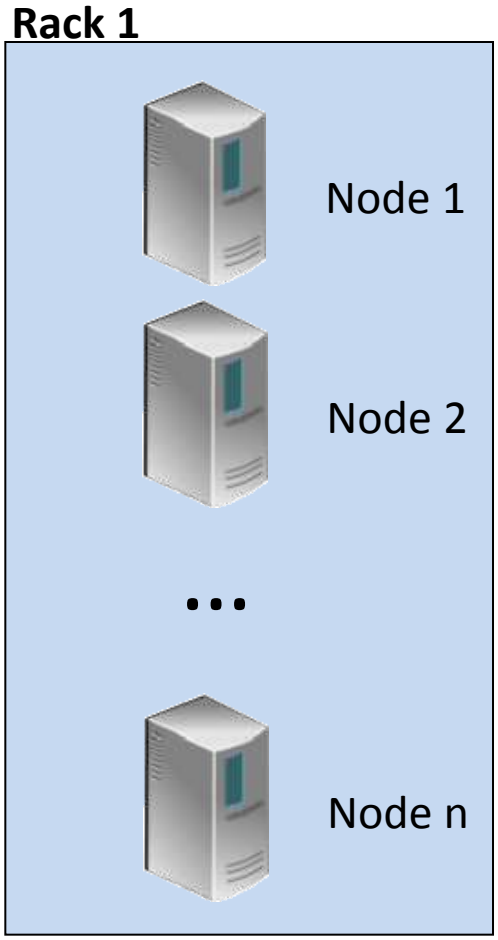
Node 1

Node 2

...

Node n

Terminology review



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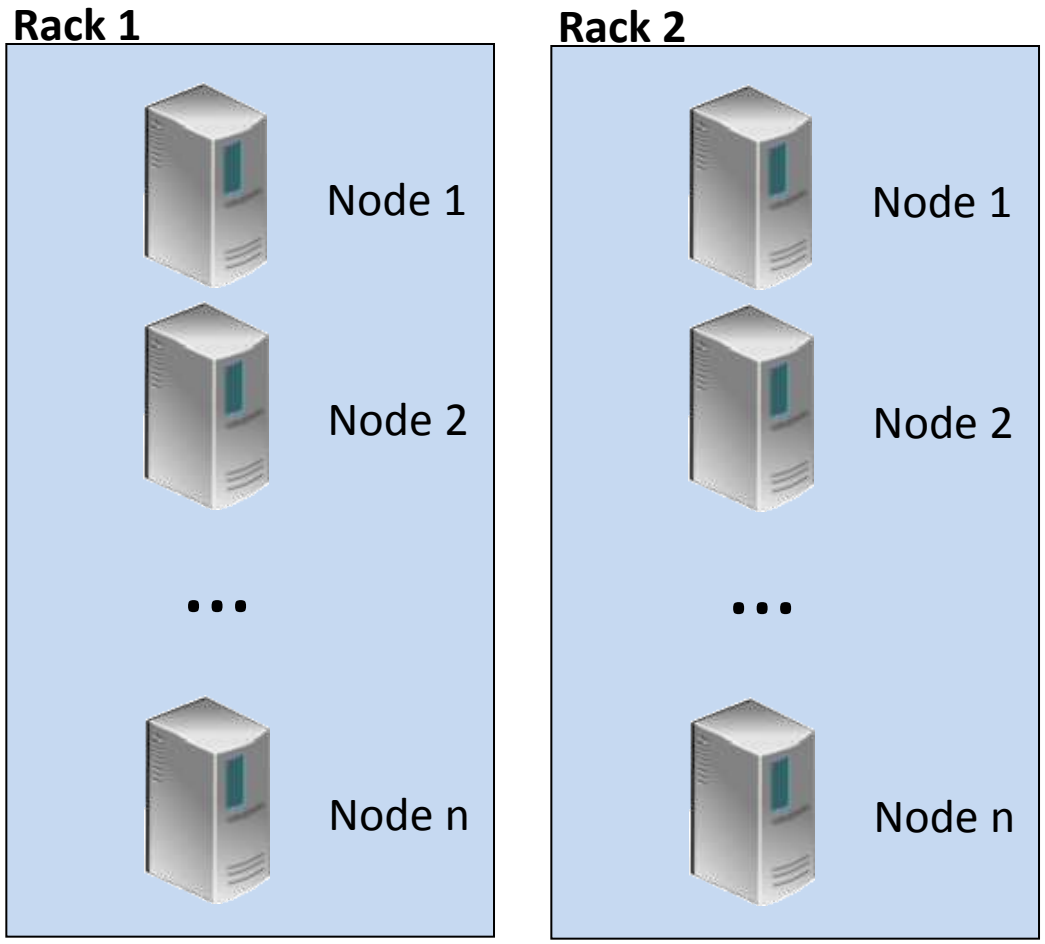

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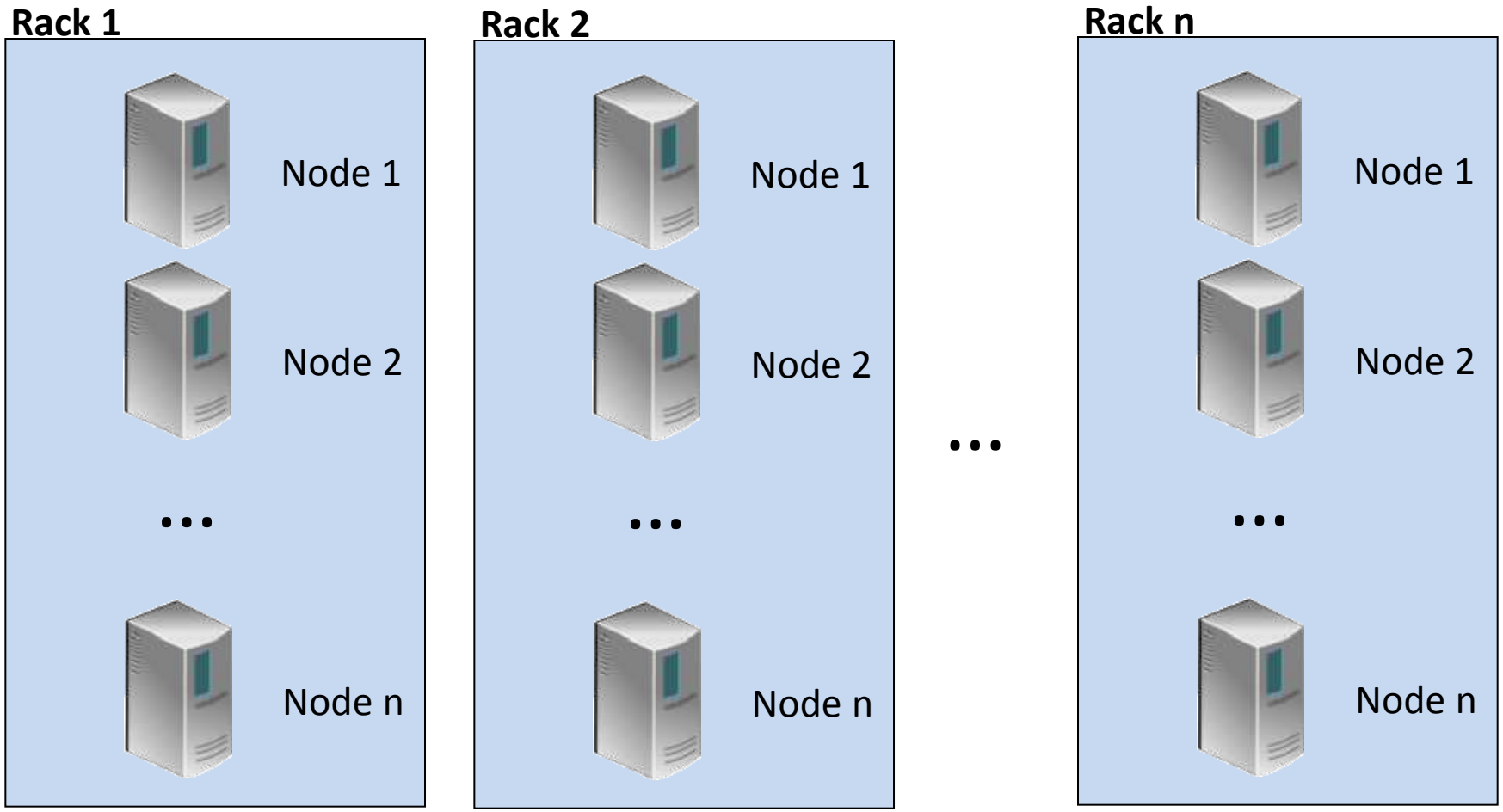

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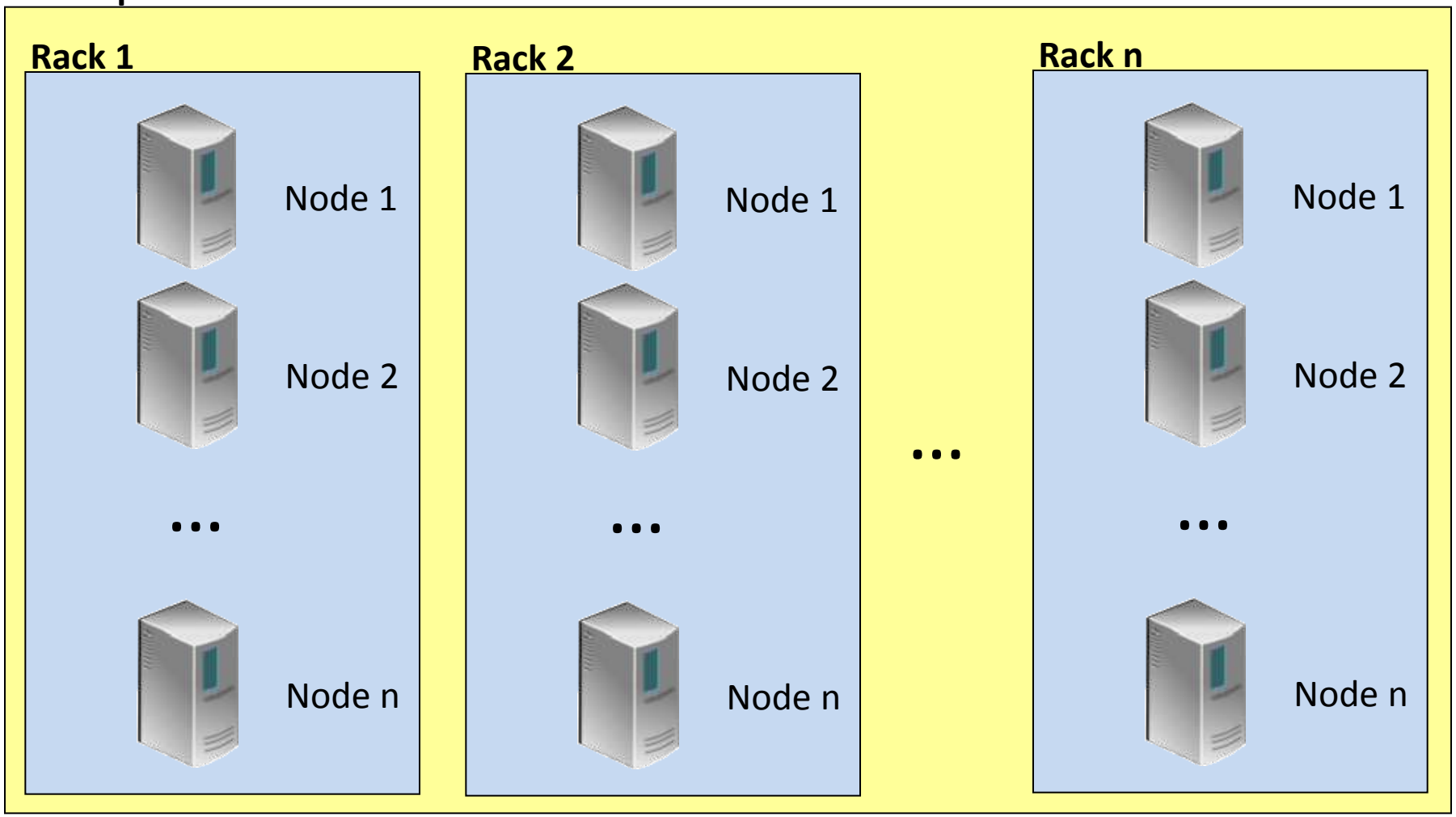
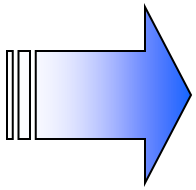


Hadoop architecture

- Two main components:
  - Hadoop Distributed File System (HDFS)
  - MapReduce Engine

Agenda



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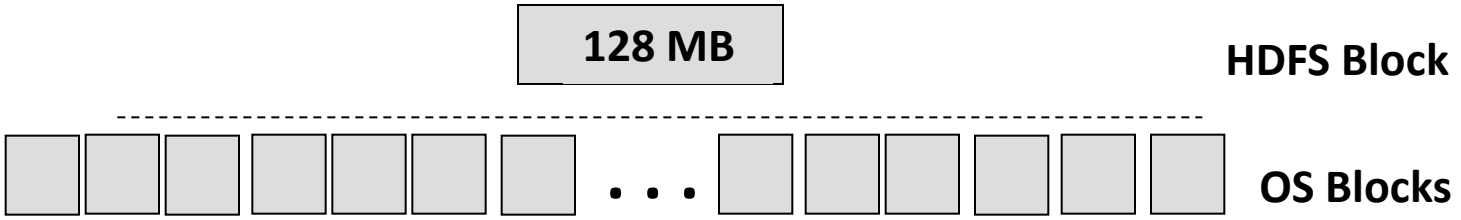
Hadoop distributed file system (HDFS)

- Hadoop file system that runs on top of existing file system
- Designed to handle very large files with streaming data access patterns
- Uses blocks to store a file or parts of a file

HDFS - Blocks

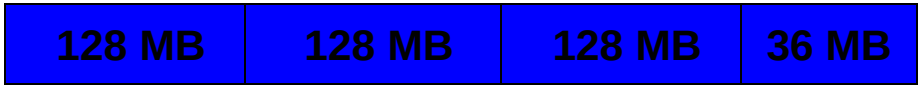
- File Blocks
  - 64MB (default), 128MB (recommended) – compare to 4KB in UNIX
  - Behind the scenes, 1 HDFS block is supported by multiple operating system (OS) blocks



HDFS - Blocks

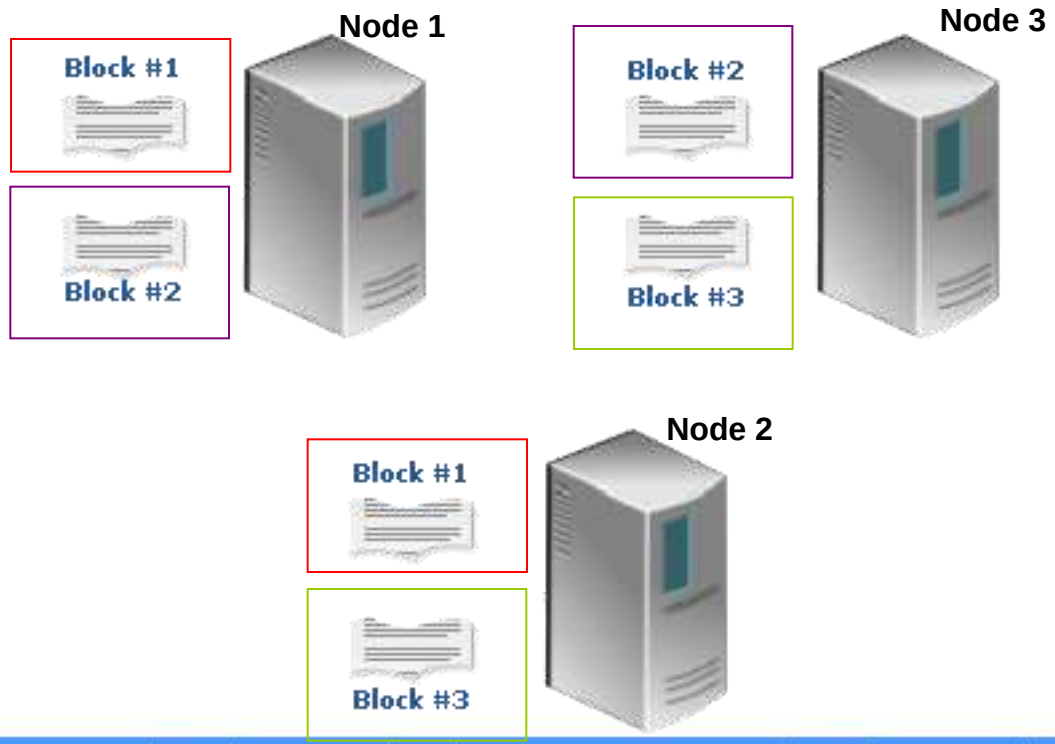
- **Fits well with replication to provide fault tolerance and availability**

- **Advantages of blocks:**
  - Fixed size – easy to calculate how many fit on a disk
  - A file can be larger than any single disk in the network
  - If a file or a chunk of the file is smaller than the block size, only needed space is used. Eg: 420MB file is split as:

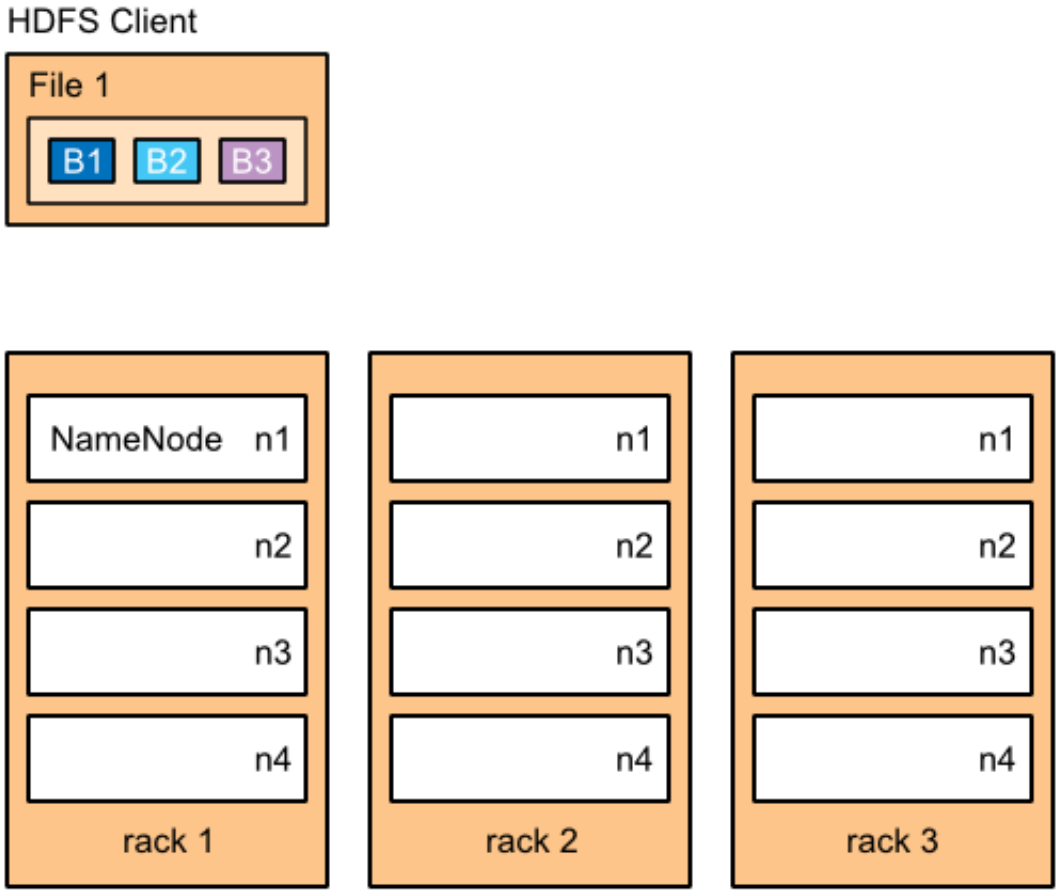


HDFS - Replication

- Blocks with data are replicated to multiple nodes
- Allows for node failure without data loss



Writing a file to HDFS



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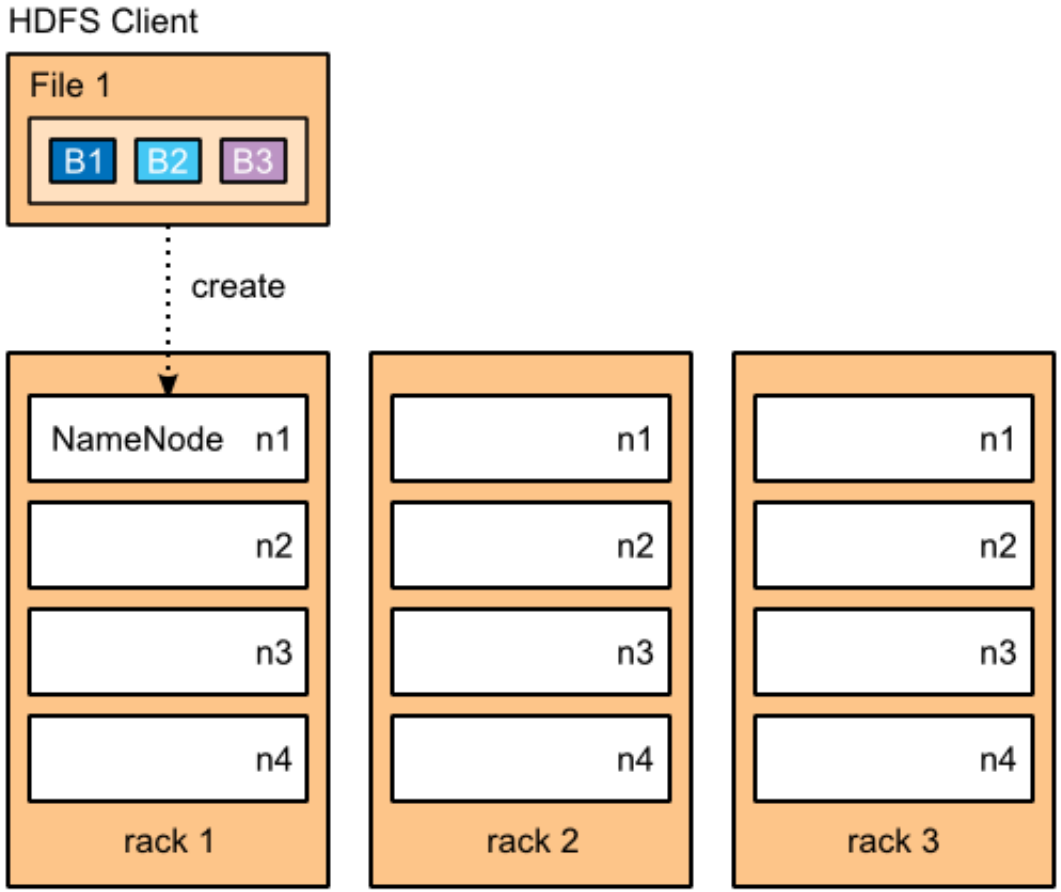

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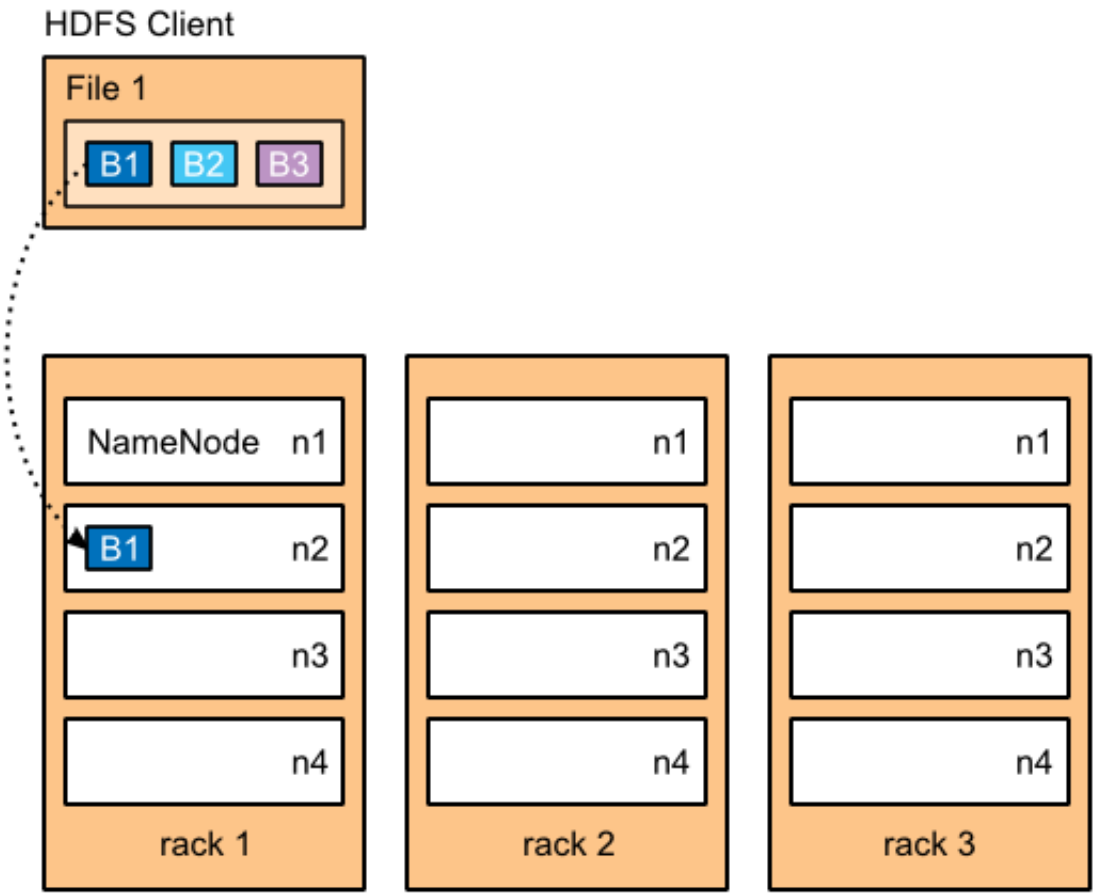

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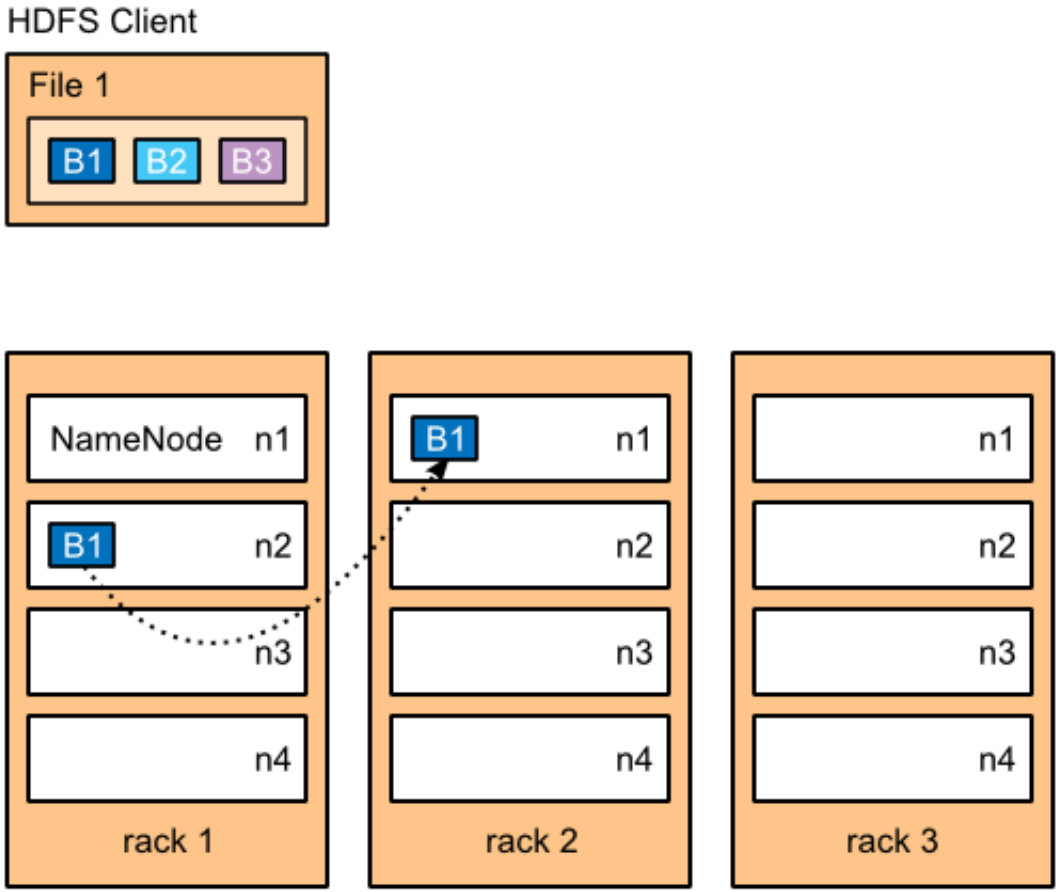

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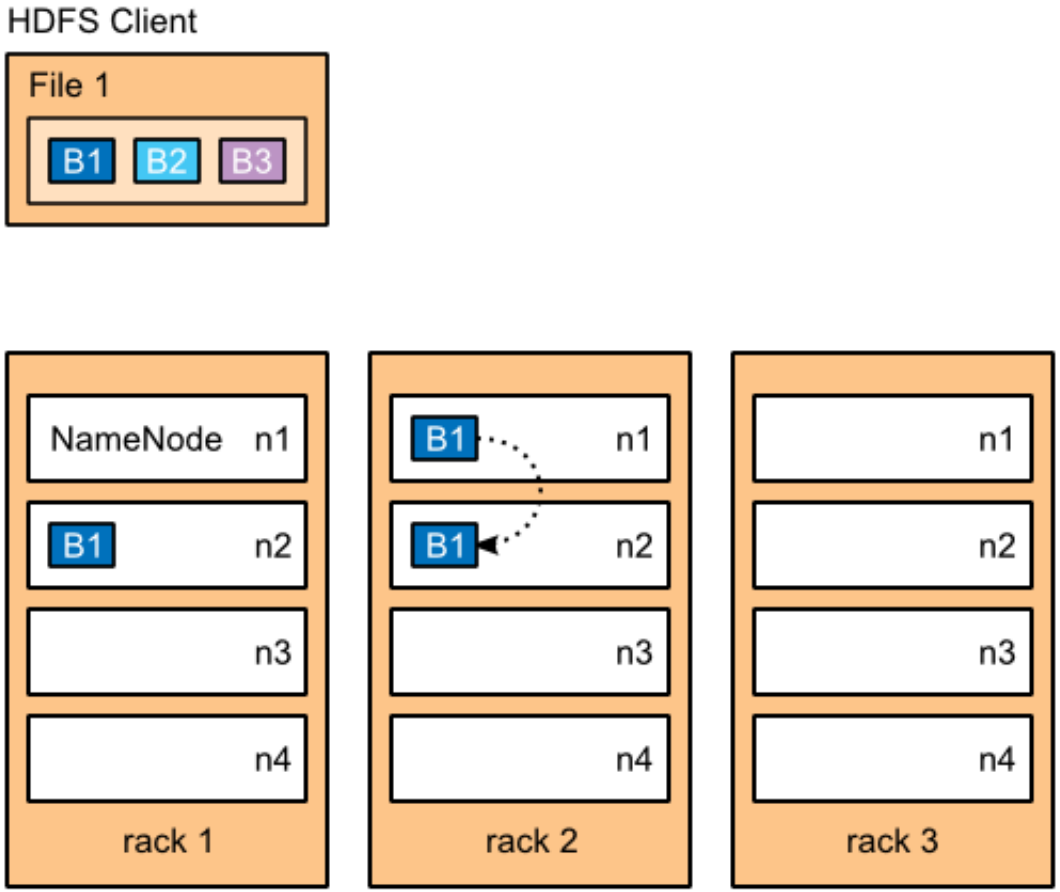

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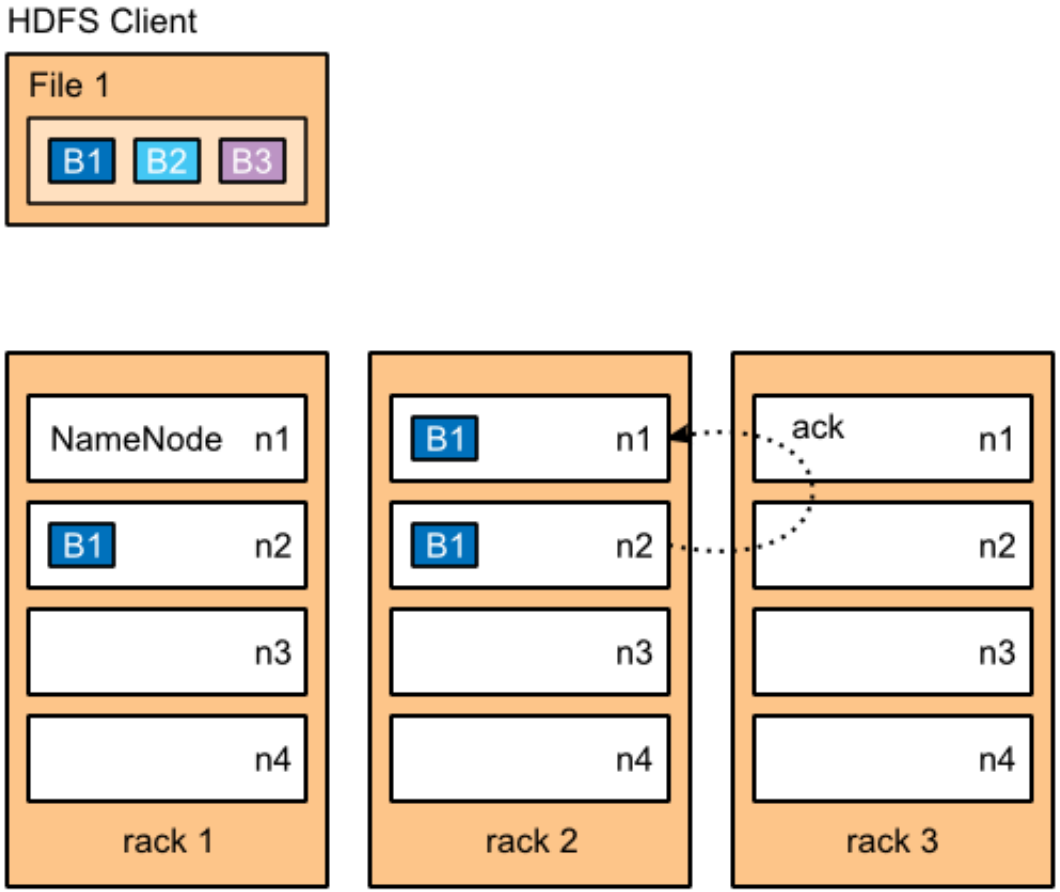

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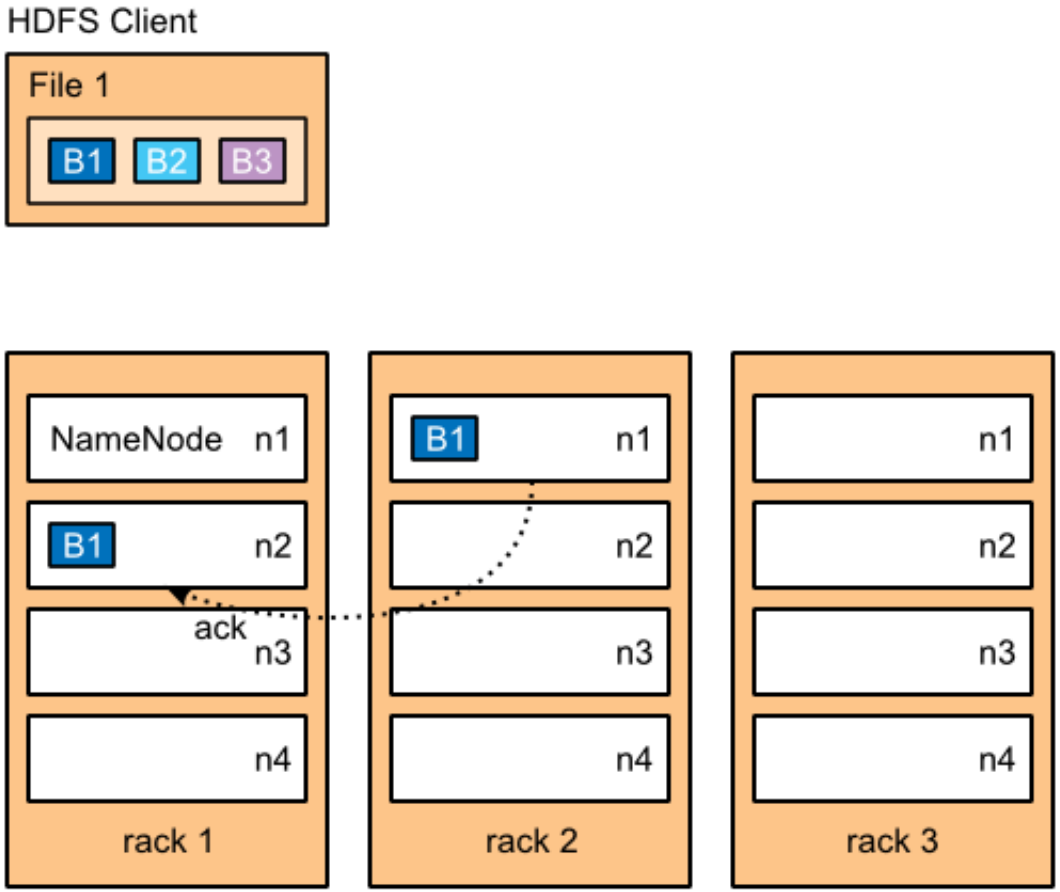

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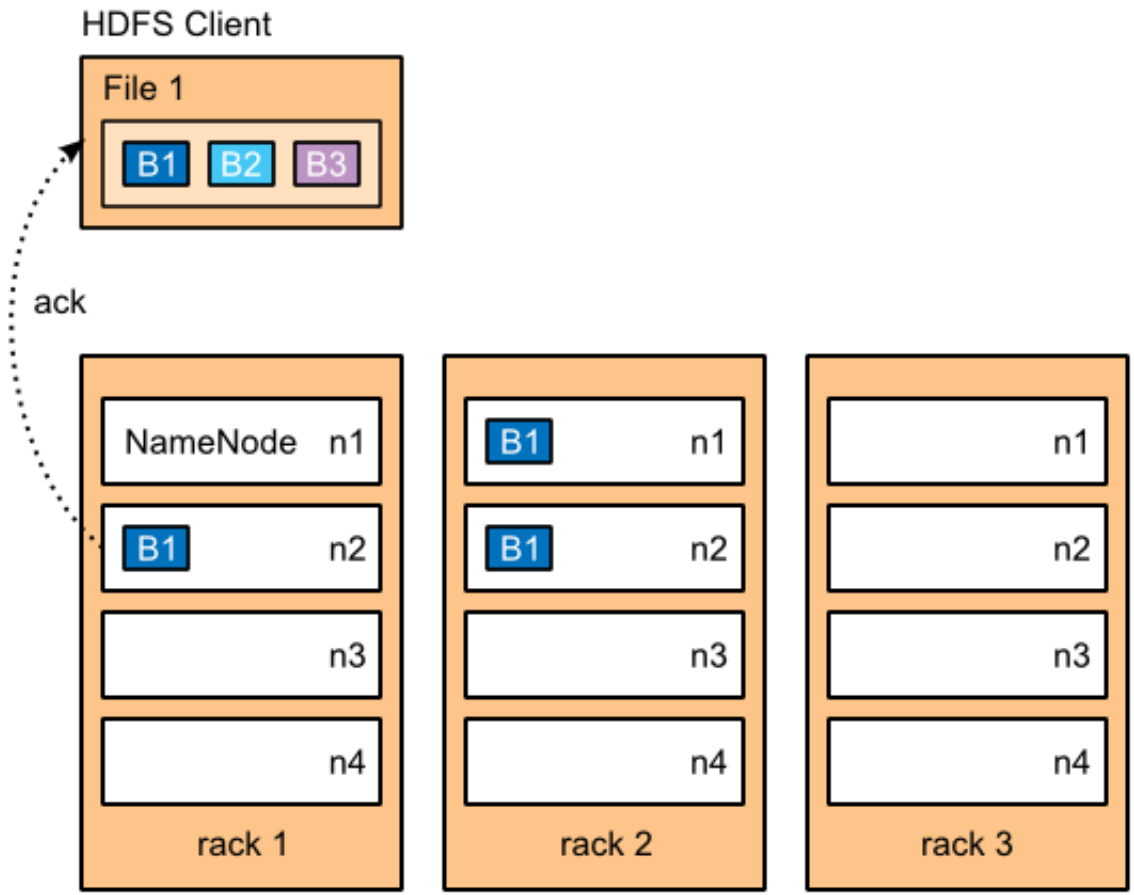

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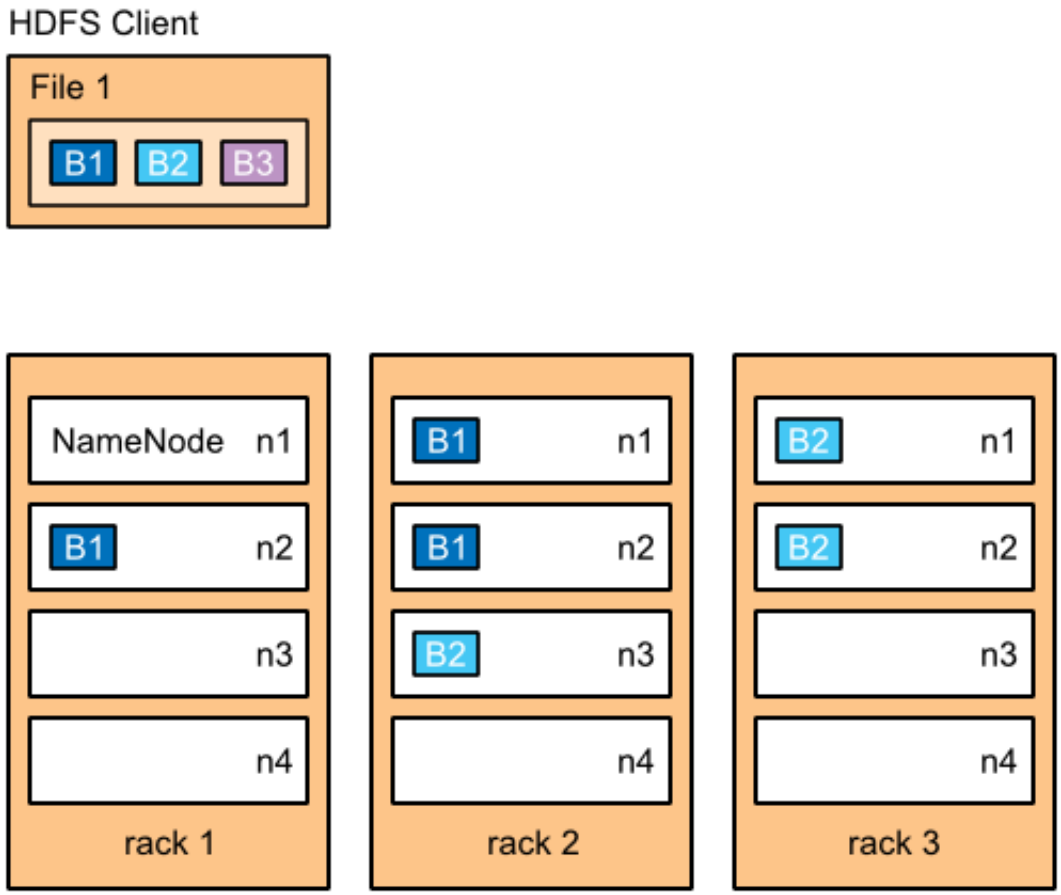

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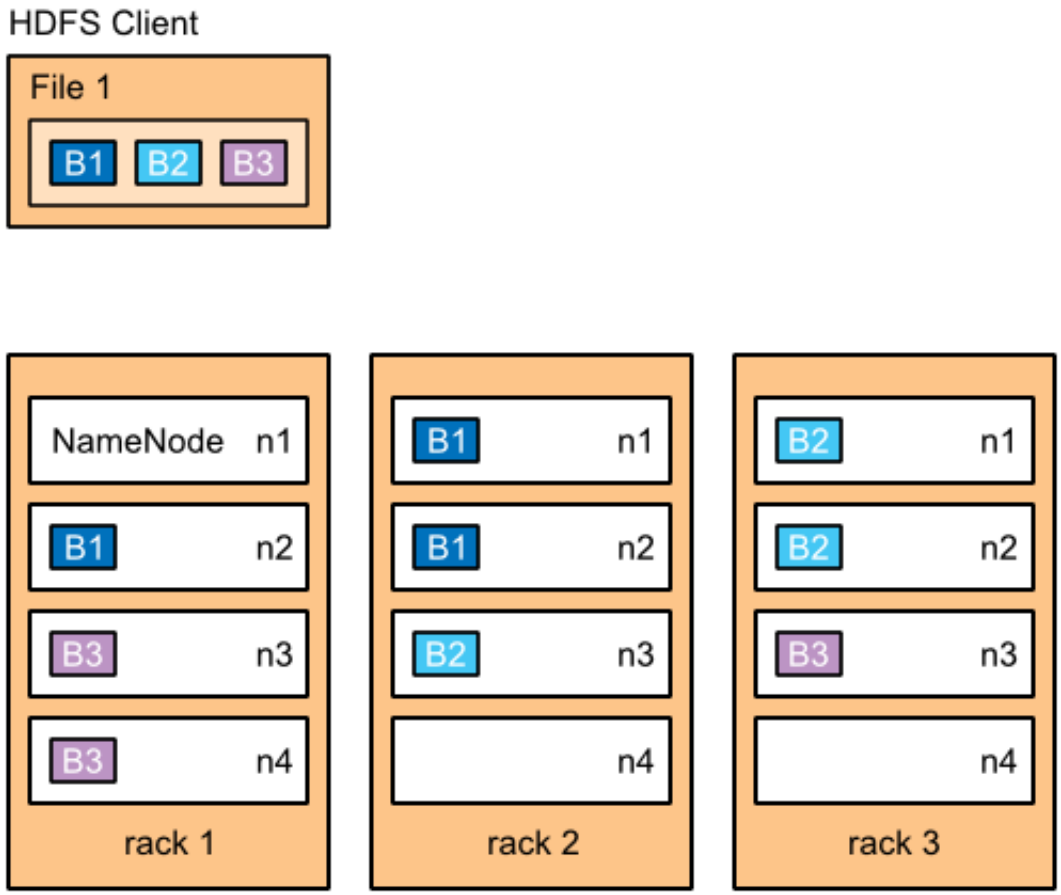

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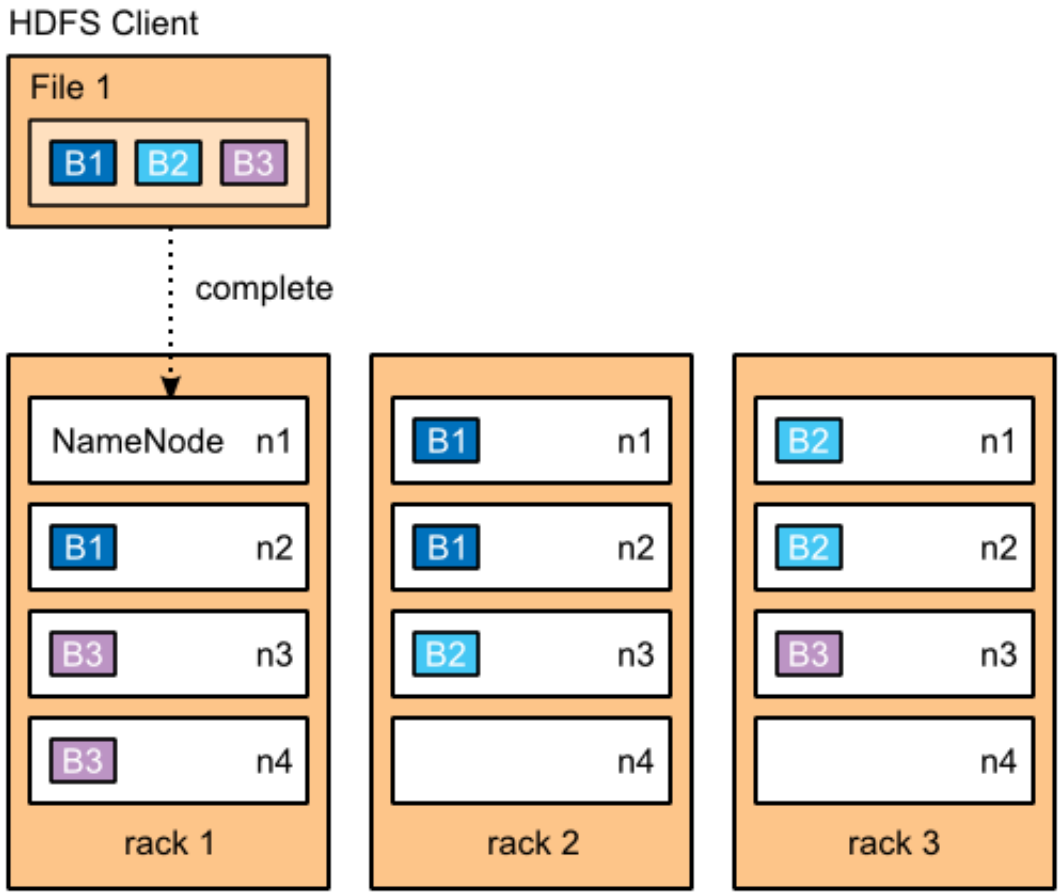


HDFS Command line interface

- **File System Shell (fs)**
  - Invoked as follows:

```
hadoop fs <args>
```

- **Example:**
  - Listing the current directory in hdfs

```
hadoop fs –ls .
```

HDFS Command line interface

- **FS shell commands take paths URIs as argument**
  - URI format: scheme://authority/path
- **Scheme:**
  - For the local filesystem, the scheme is *file*
  - For HDFS, the scheme is *hdfs*

```
hadoop fs –copyFromLocal
        file://myfile.txt
        hdfs://localhost/user/keith/myfile.txt
```

- **Scheme and authority are optional**
  - Defaults are taken from configuration file core-site.xml

HDFS Command line interface

- **Many POSIX-like commands**
  - cat, chgrp, chmod, chown, cp, du, ls, mkdir, mv, rm, stat, tail
- **Some HDFS-specific commands**
  - copyFromLocal, copyToLocal, get, getmerge, put, setrep

HDFS – Specific commands

- **copyFromLocal / put**
  - Copy files from the local file system into fs

```
hadoop fs -copyFromLocal <localsrc> .. <dst>
```

Or

```
hadoop fs -put <localsrc> .. <dst>
```

HDFS – Specific commands

- **copyToLocal / get**
  - Copy files from fs into the local file system

```
hadoop fs -copyToLocal [-ignorecrc] [-crc]
                                    <src> <localdst>
```

Or

```
hadoop fs -get [-ignorecrc] [-crc]
                                    <src> <localdst>
```

HDFS – Specific commands

- **getMerge**
  - Get all the files in the directories that match the source file pattern
  - Merge and sort them to only one file on local fs
  - <src> is kept

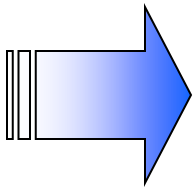
hadoop fs -getmerge <src> <localdst>

HDFS – Specific commands

- **setRep**
  - Set the replication level of a file.
  - The -R flag requests a recursive change of replication level for an entire tree.
  - If -w is specified, waits until new replication level is achieved.

```
hadoop fs -setrep [-R] [-w] <rep> <path/file>
```

Agenda



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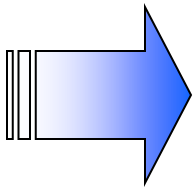
MapReduce engine

- Technology from Google
- A MapReduce program consists of map and reduce functions
- A MapReduce job is broken into tasks that run in parallel

Agenda



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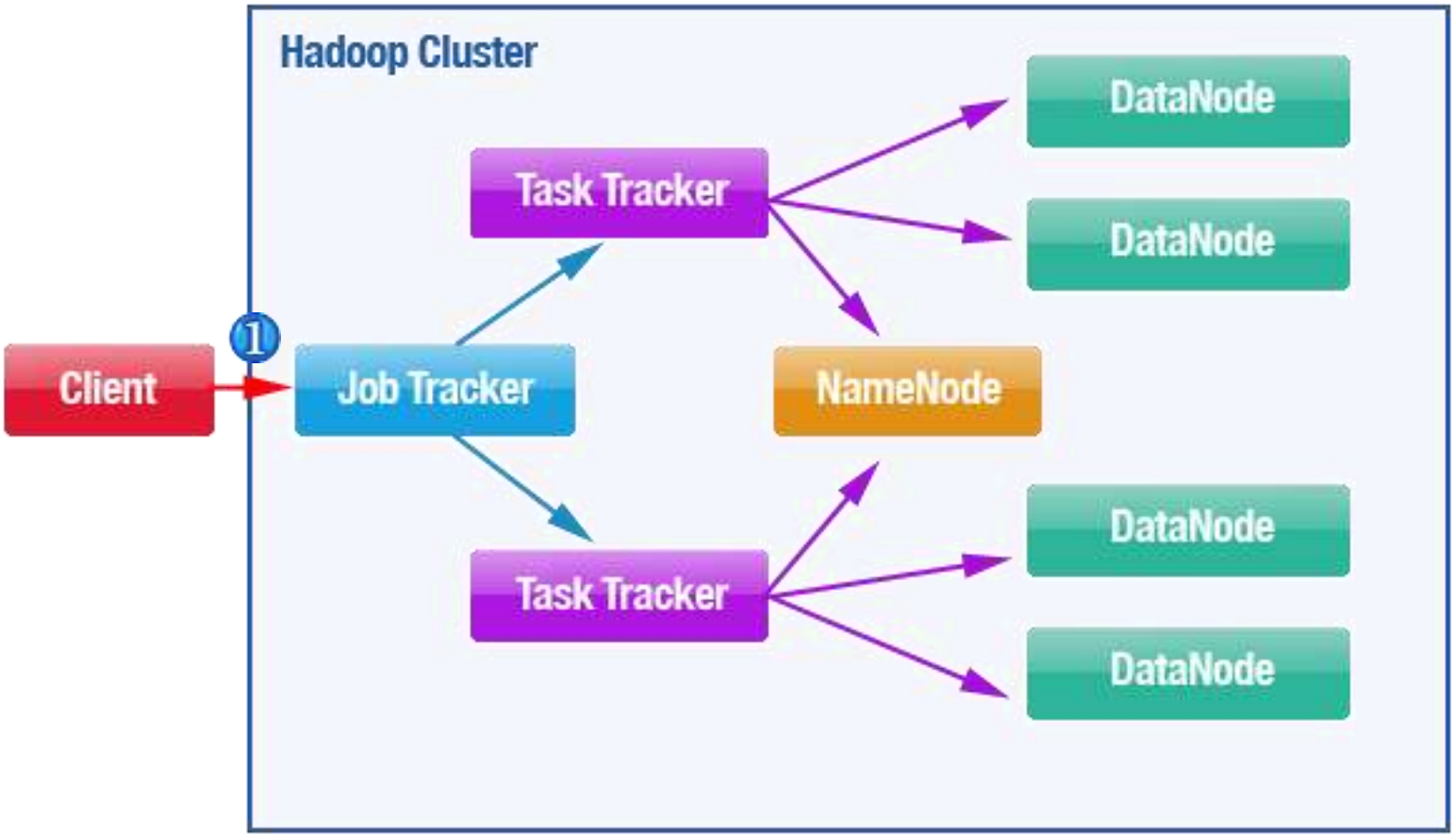
Types of nodes - Overview

- **HDFS nodes**
  - NameNode
  - DataNode
- **MapReduce nodes**
  - JobTracker
  - TaskTracker
- **There are other nodes not discussed in this course**

Types of nodes - Overview



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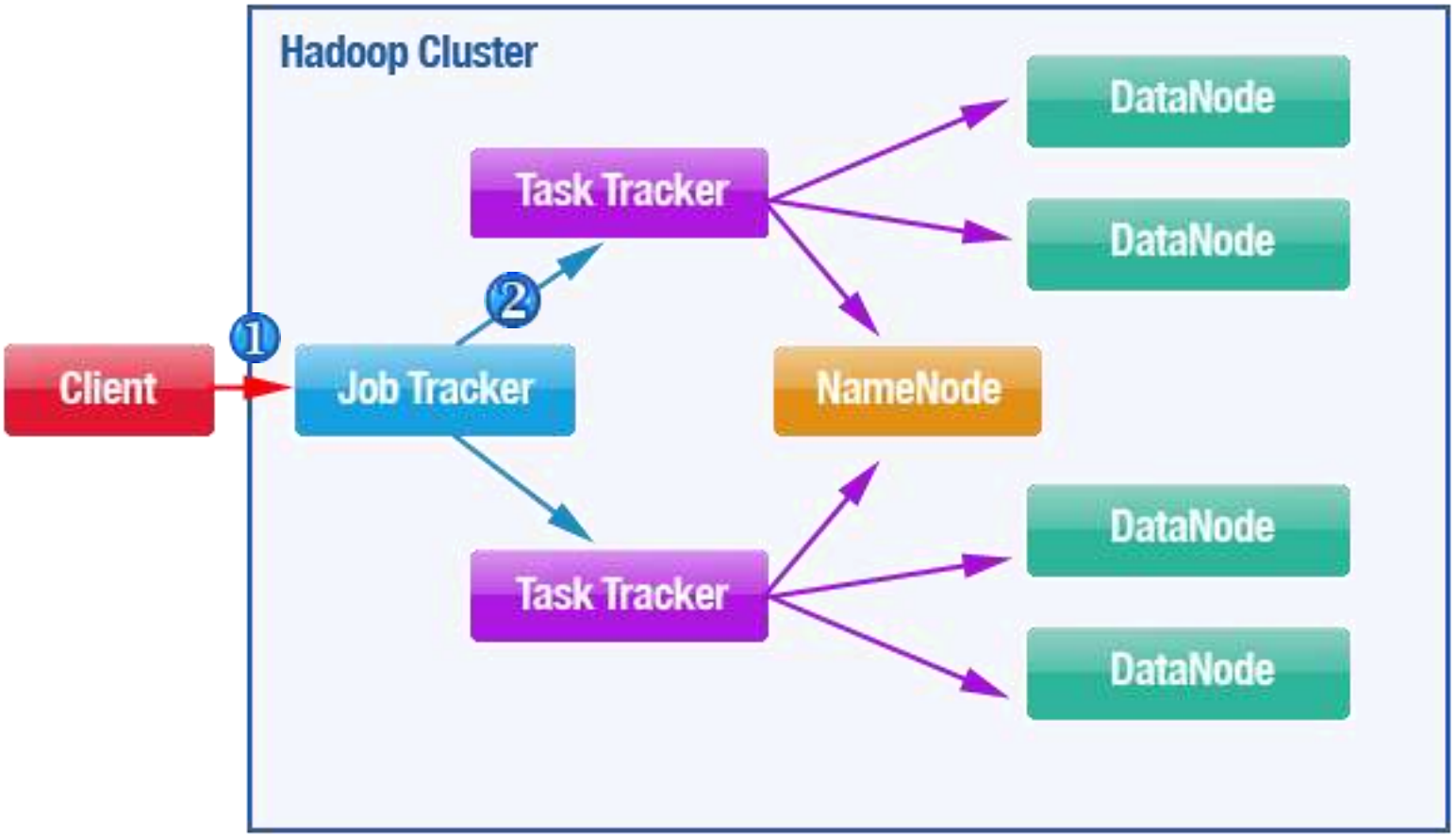

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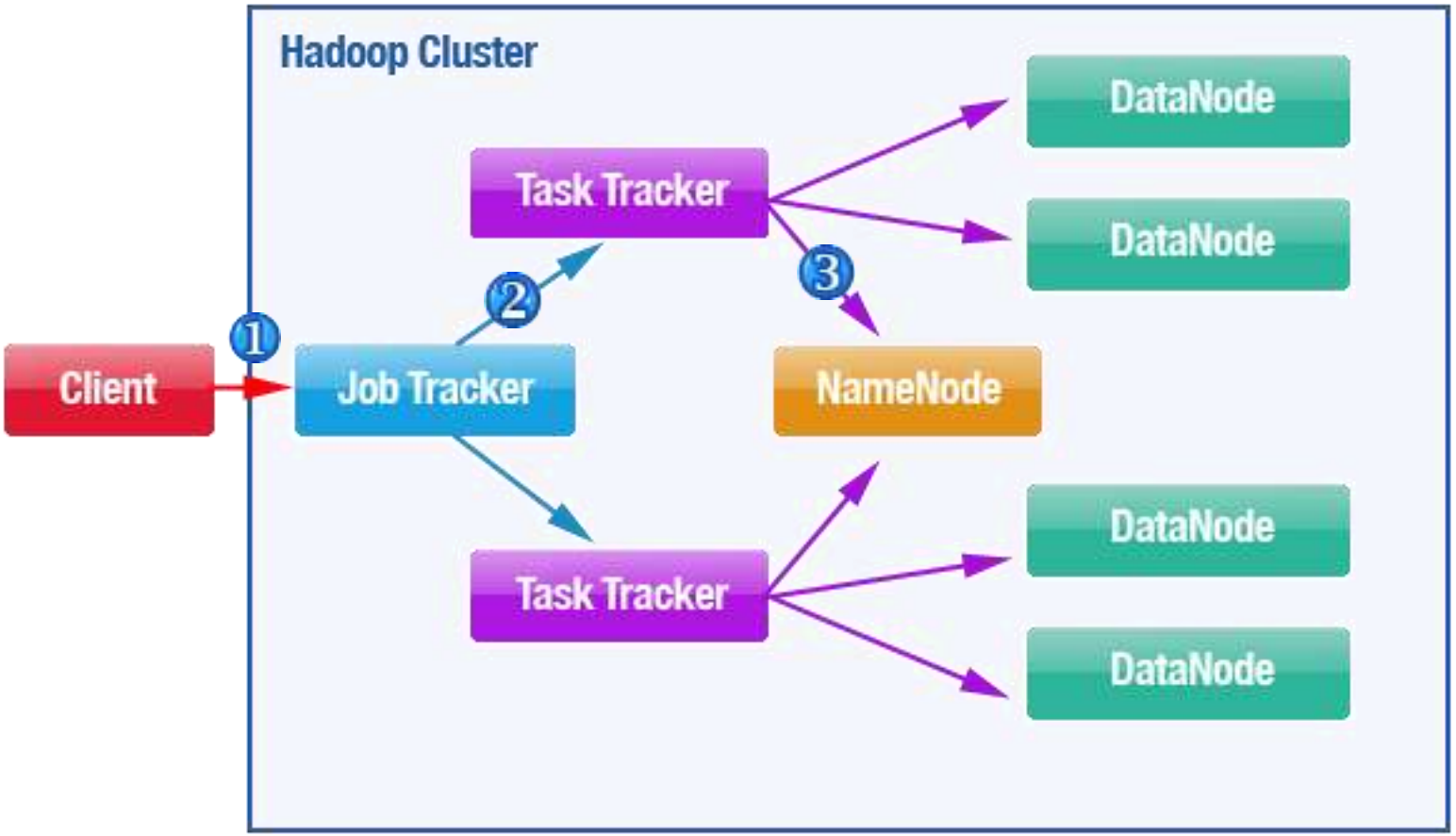

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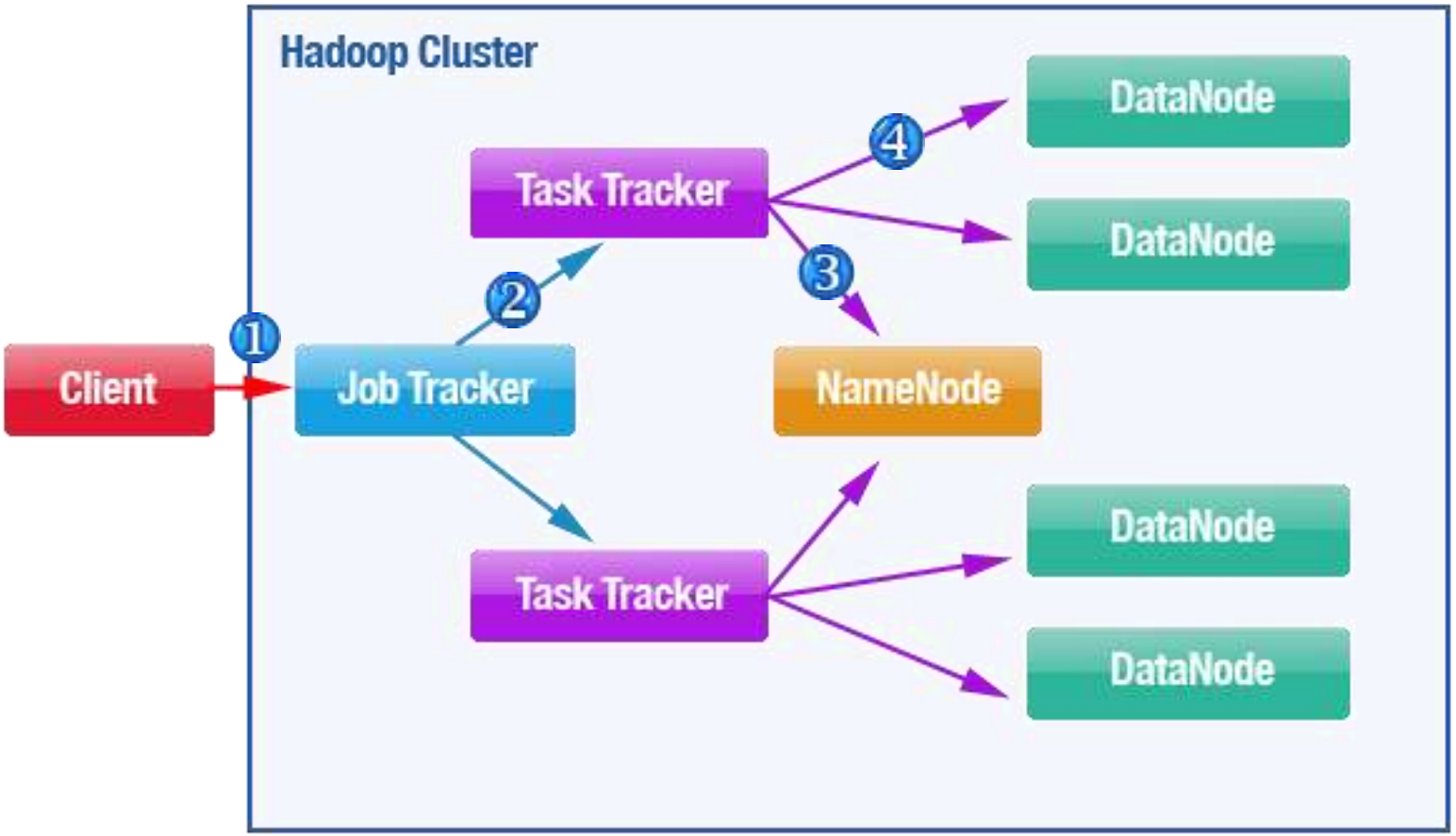
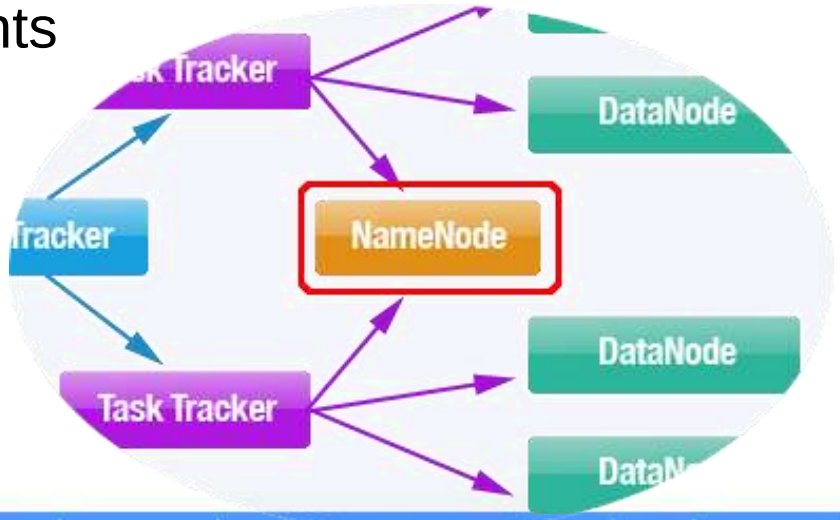


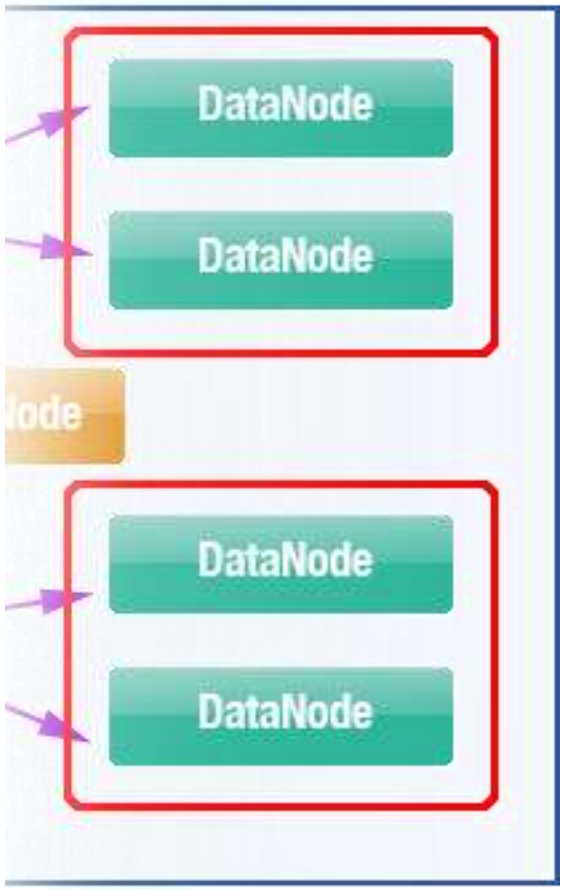
Types of nodes - NameNode

- **NameNode**
  - Only one per Hadoop cluster
  - Manages the filesystem namespace and metadata
  - Single point of failure, but mitigated by writing state to multiple filesystems
  - Single point of failure: Don't use inexpensive commodity hardware for this node, large memory requirements



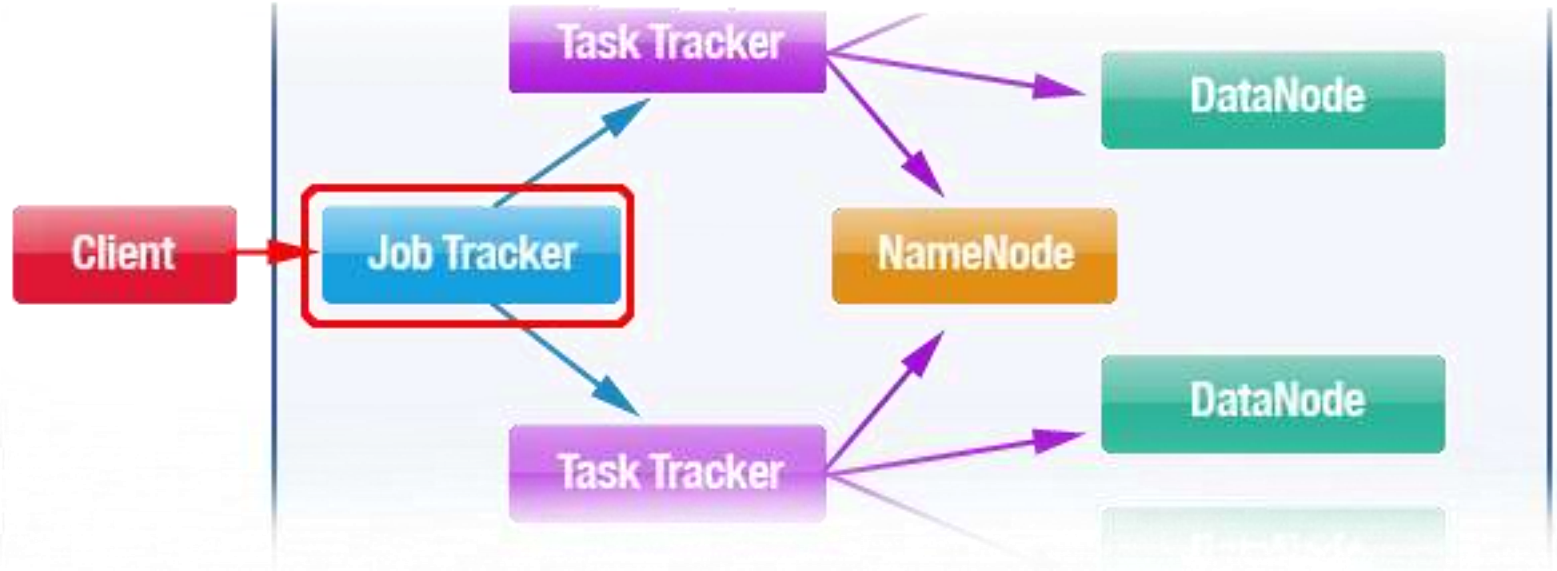
Types of nodes - DataNode

- **DataNode**
  - Many per Hadoop cluster
  - Manages blocks with data and serves them to clients
  - Periodically reports to name node the list of blocks it stores
  - Use inexpensive commodity hardware for this node



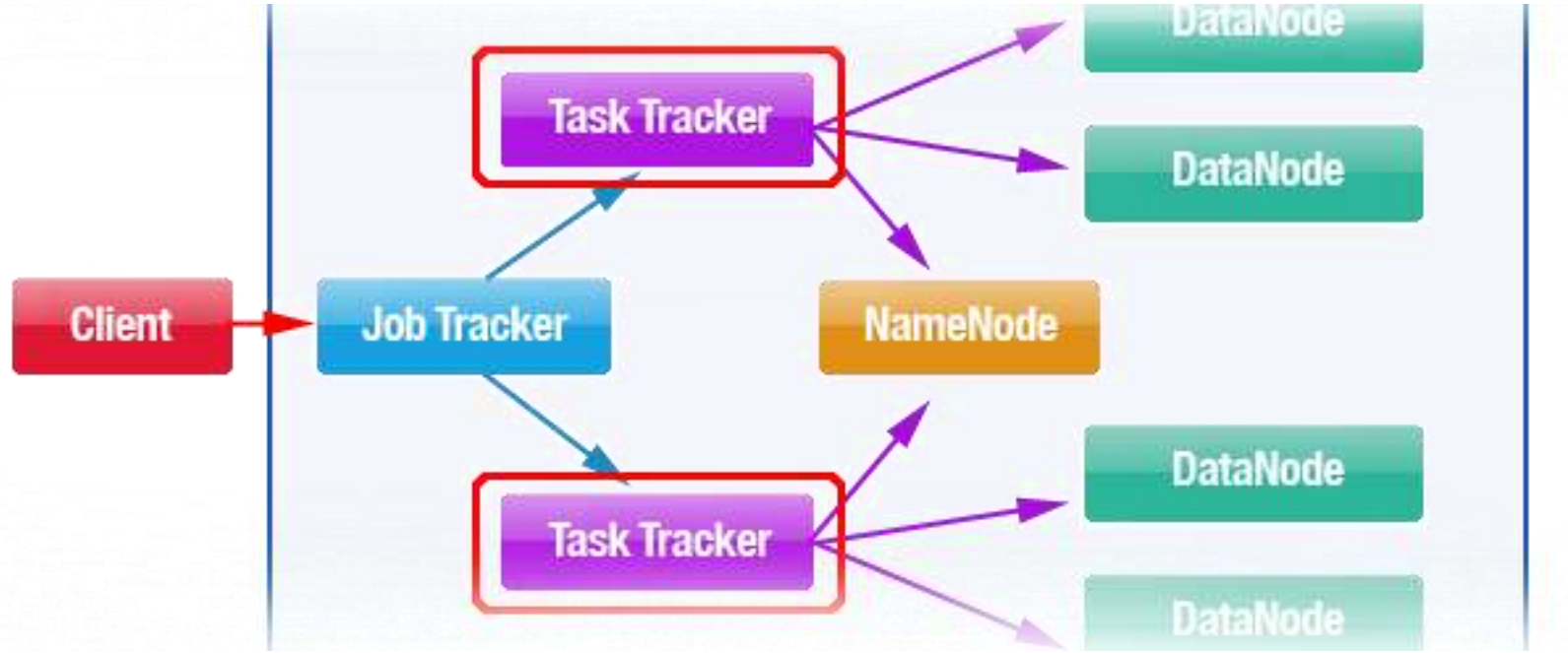
Types of nodes - JobTracker

- **JobTracker node**
  - One per Hadoop cluster
  - Receives job requests submitted by client
  - Schedules and monitors MapReduce jobs on task trackers



Types of nodes - TaskTracker

- **TaskTracker node**
  - Many per Hadoop cluster
  - Executes MapReduce operations
  - Reads blocks from DataNodes



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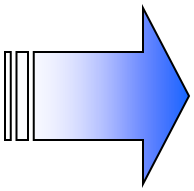
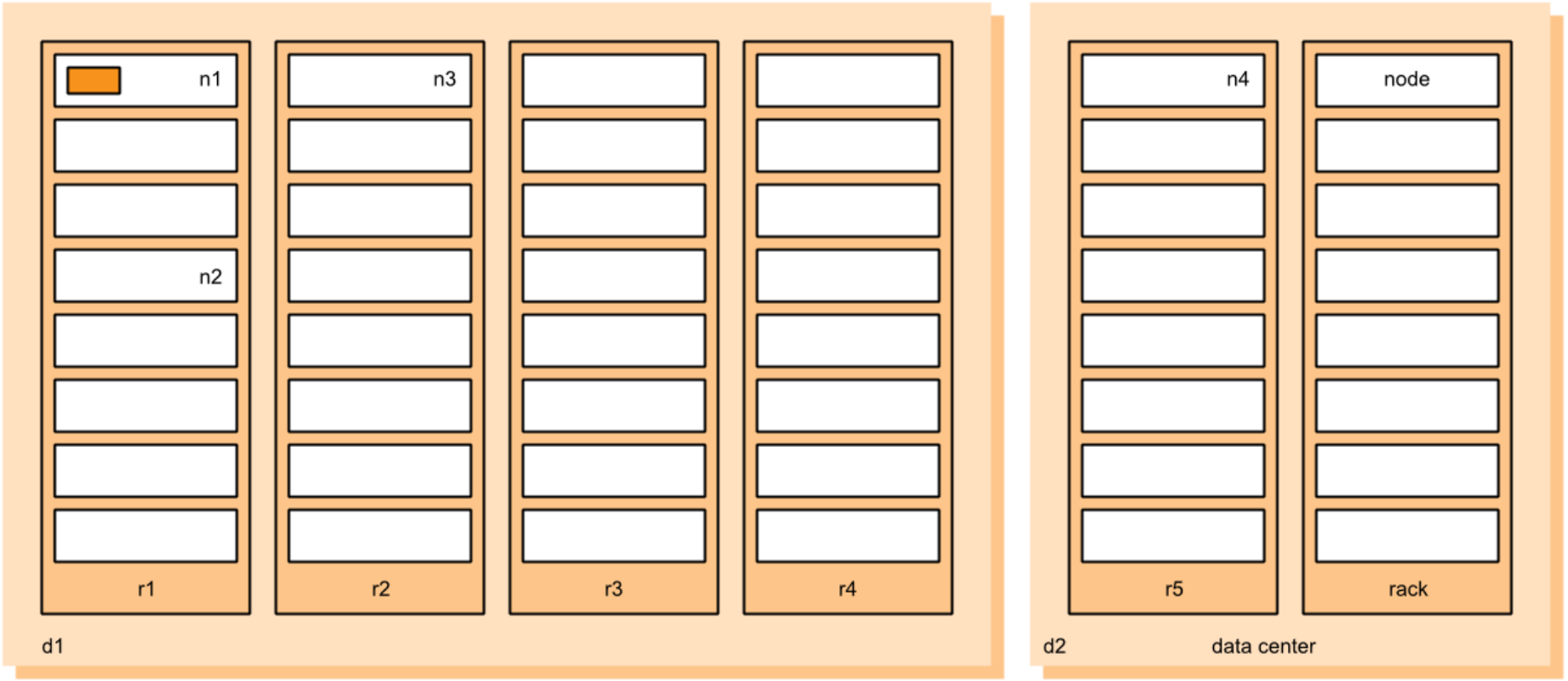


- Topology awareness

Topology awareness (or Rack awareness)

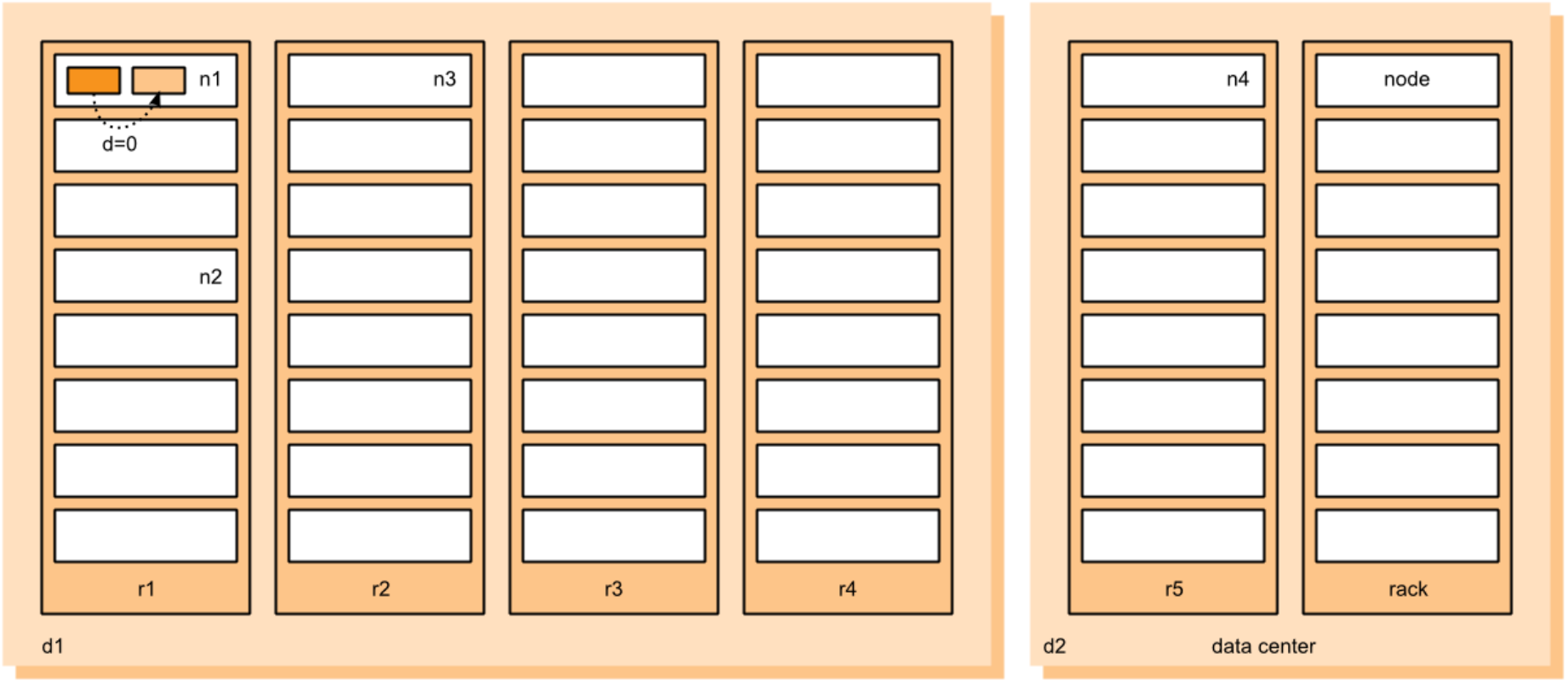
Bandwidth becomes progressively smaller in the following scenarios:



Topology awareness

Bandwidth becomes progressively smaller in the following scenarios:

1.Process on the same node.

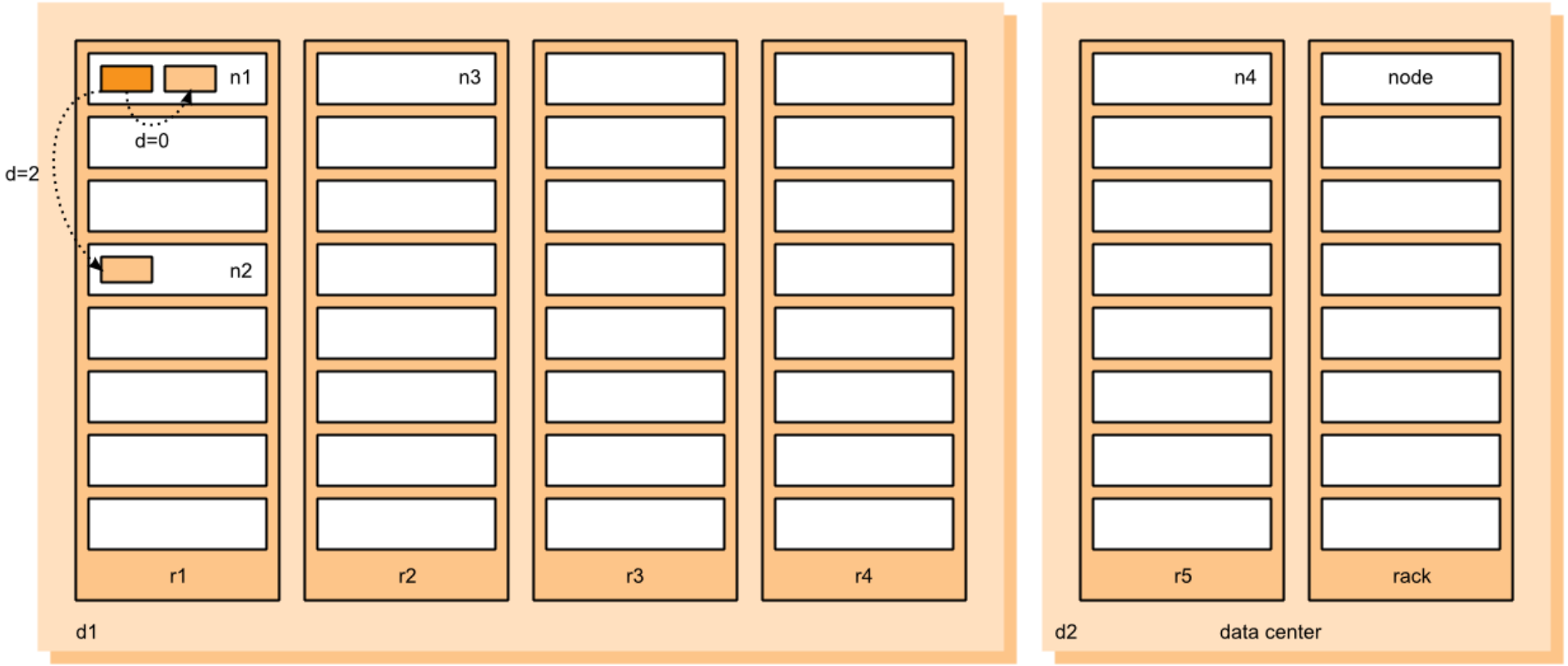


Topology awareness

Bandwidth becomes progressively smaller in the following scenarios:

1.Process on the same node

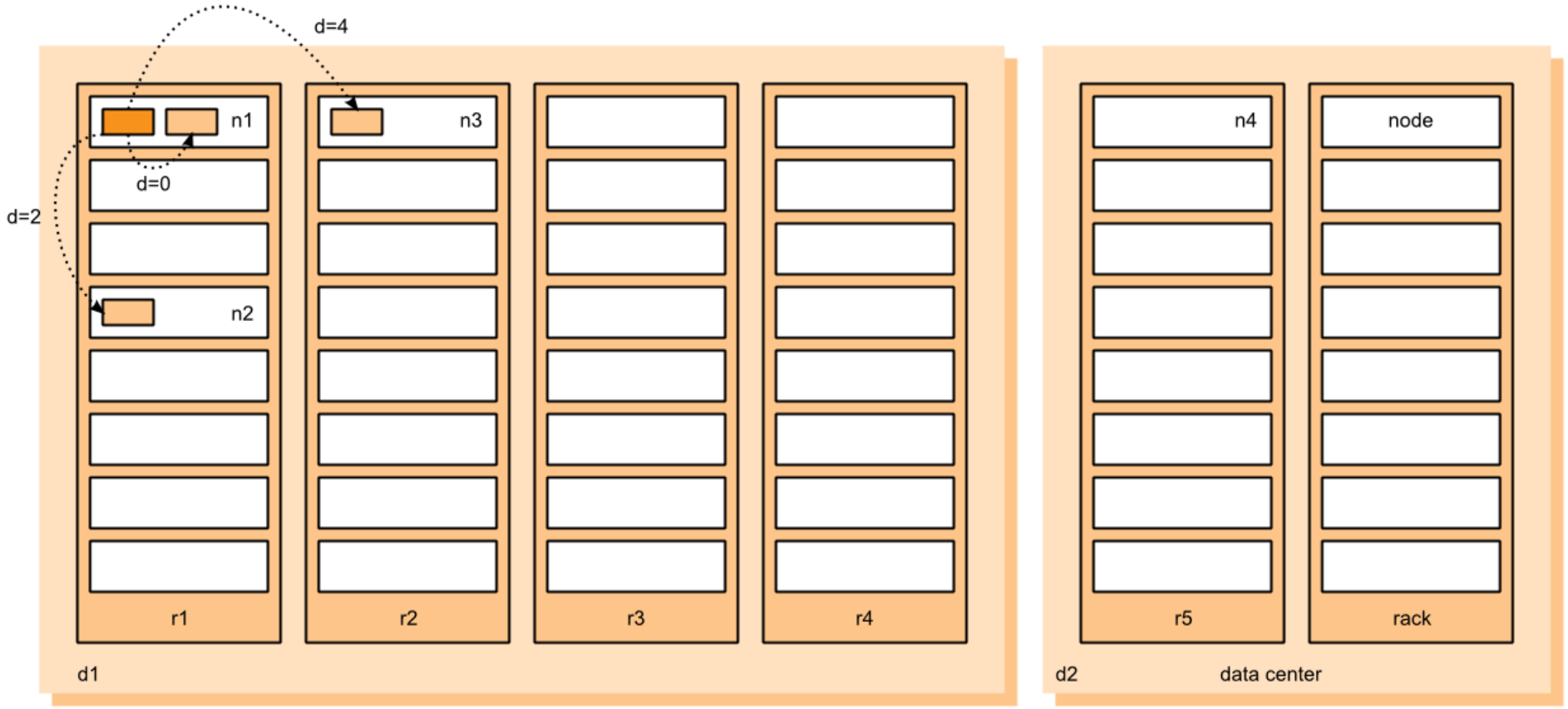
2.Different nodes on the same rack



Topology awareness

Bandwidth becomes progressively smaller in the following scenarios:

1. Process on the same node
2. Different nodes on the same rack
3. Nodes on different racks in the same data center



Topology awareness

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1. Process on the same node
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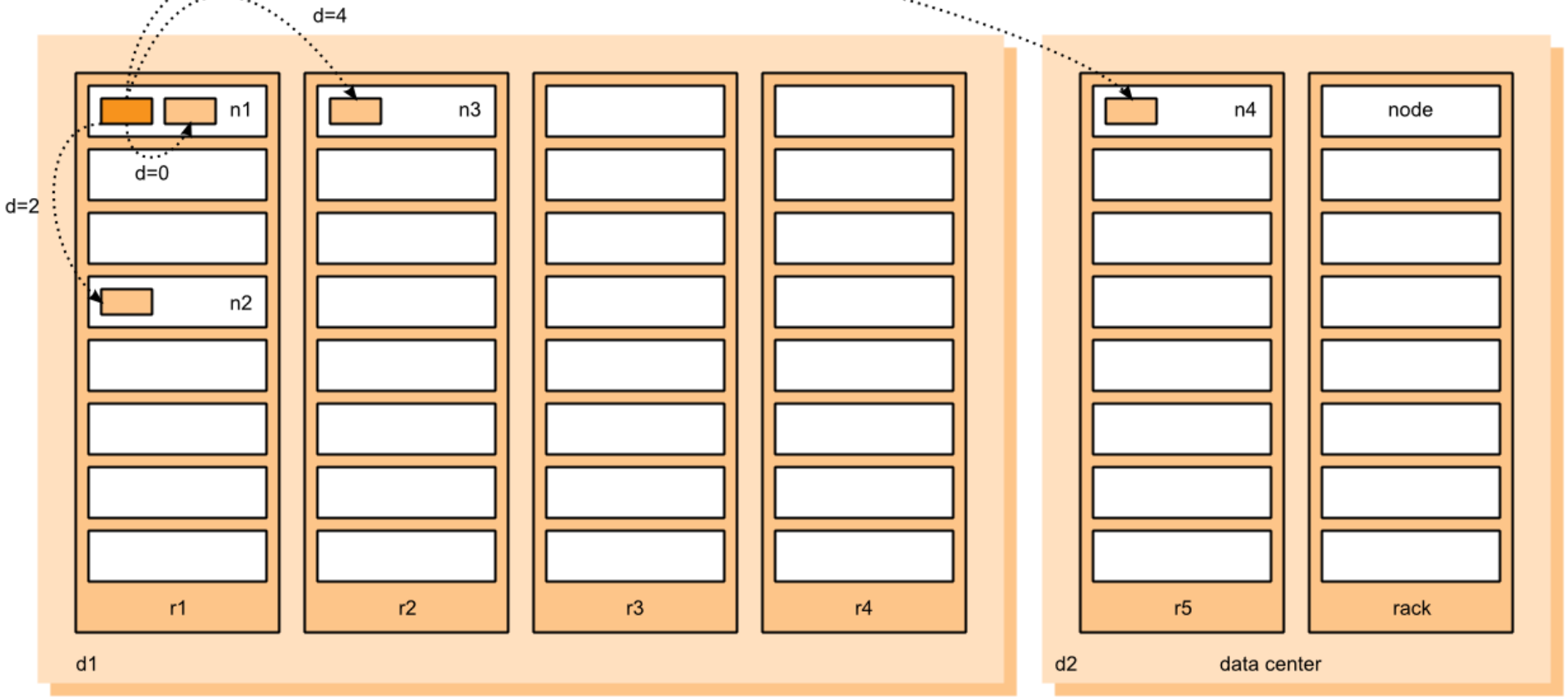
4. Nodes in different data centers



Thank you!