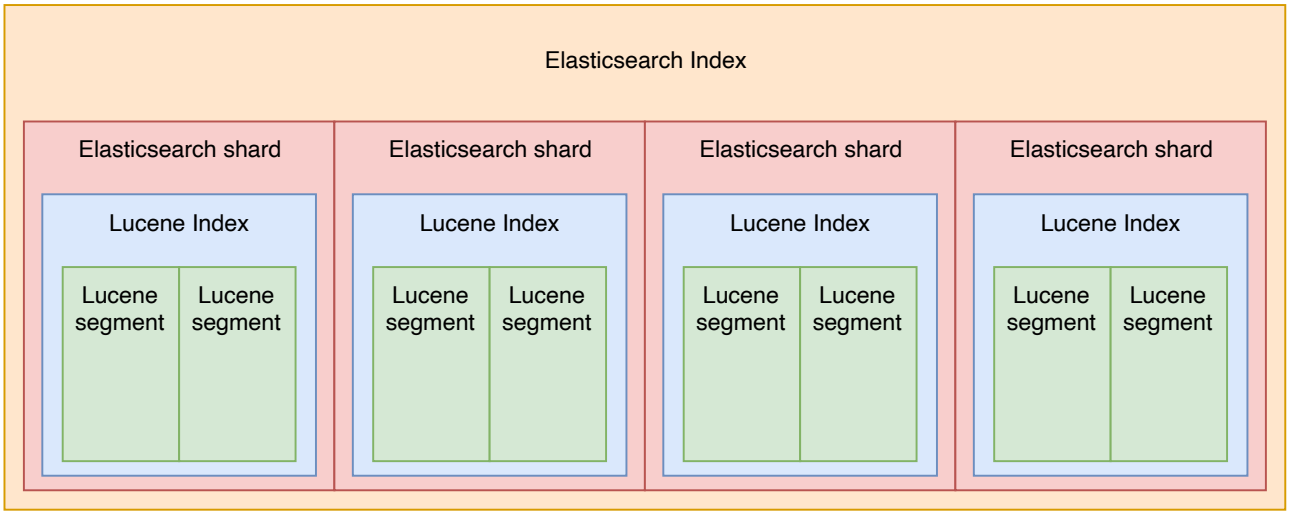
Elastic cluster tuning and optimisations

Why refresh interval is important and what shall we do about it?

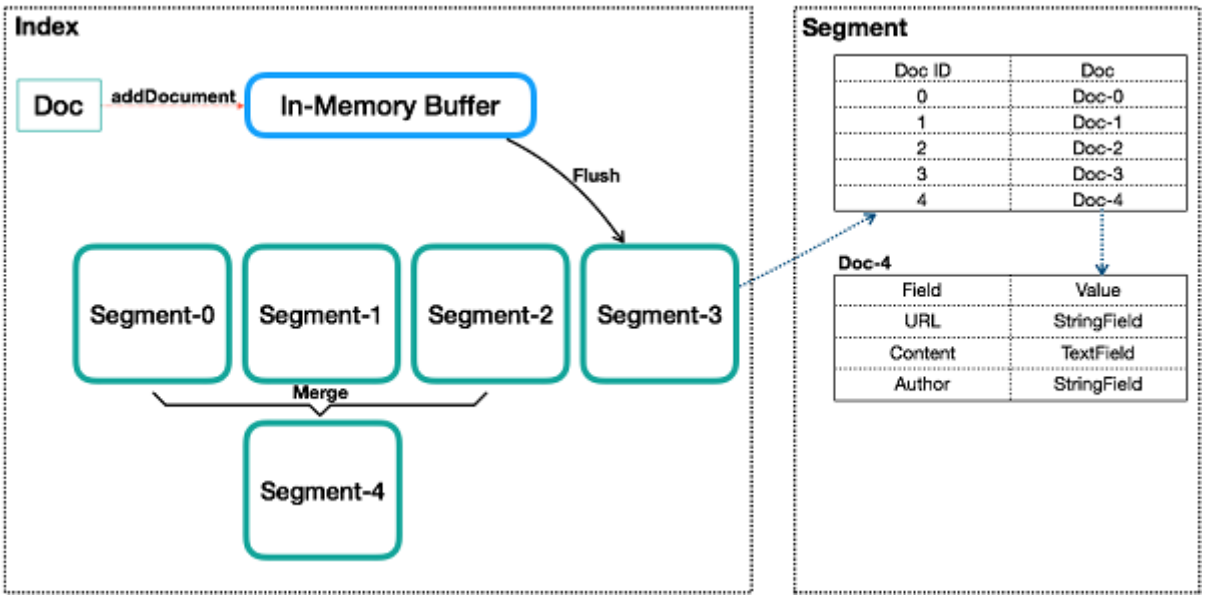
Elasticsearch is near-realtime, in the sense that when you index a document, you need to wait for the next refresh for that document to appear in search. If you are planning to index a lot of documents and you don't need the new information to be immediately available for search, you can optimize for indexing performance over search performance by decreasing refresh frequency until you are done indexing. When documents are added to an ES index, they are divided into Shards. Shards of an index are in turn are composed of multiple segments.



These segments are created with every refresh and subsequently merged together over time in the background. The lucene working behind the scenes is responsible for segment merging, but if not handled carefully it can be computationally very expensive and may cause Elasticsearch to automatically throttle indexing requests to a single thread.(ouch!)

If you are planning to index a lot of documents and you don't need the new information to be immediately available for search, you can optimize for indexing performance over search performance by decreasing refresh frequency until you are done indexing.

When does my data becomes searchable?

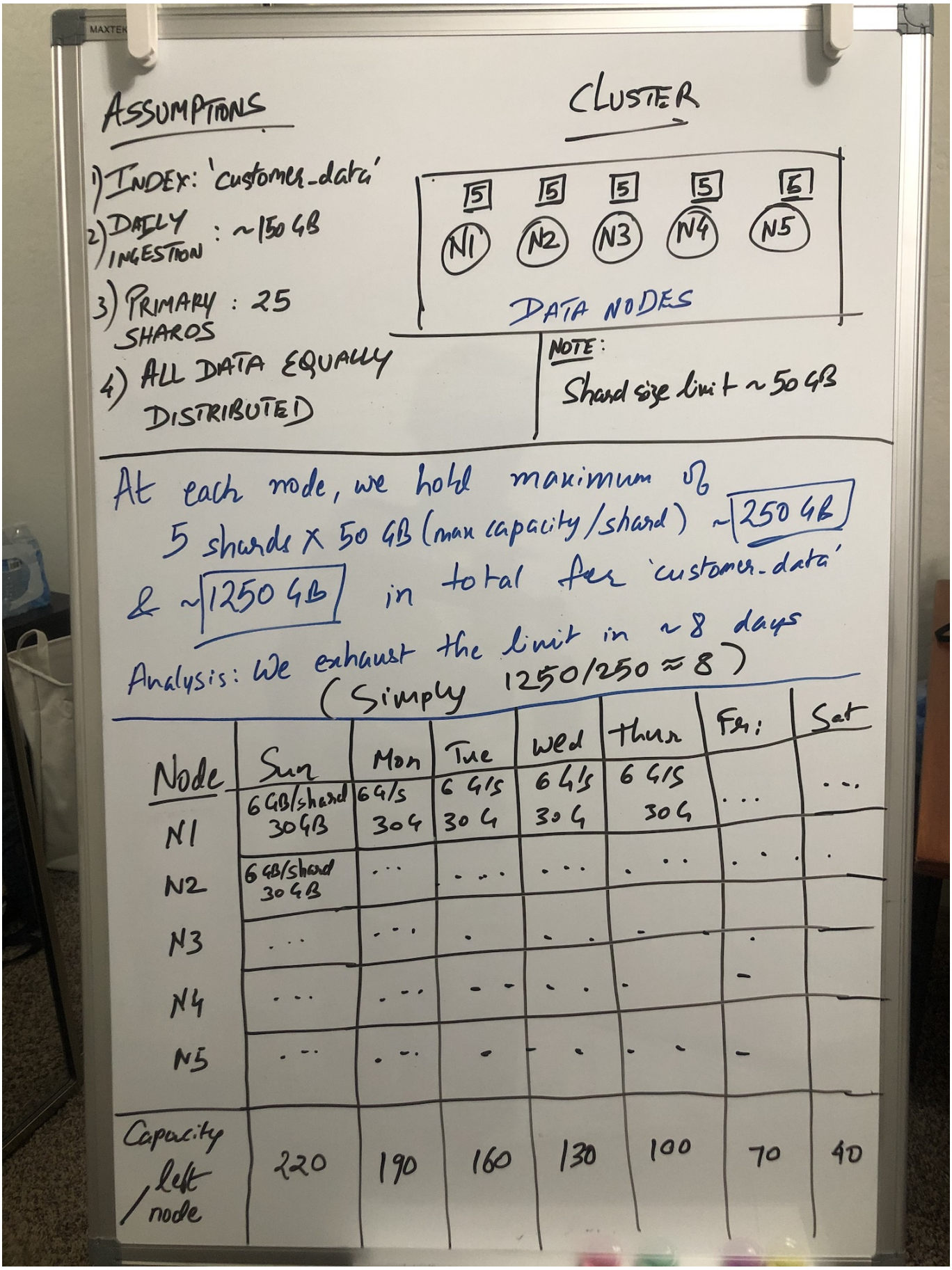


The data is first ingested into an in-memory buffer which when overflows flushes the data and creates a sizeable segment. When a segment size grows up, different segments are clustered together thereby actually deleting the documents marked as `deleted` earlier. It is when inside segment that the data becomes searchable.

During a merge, Lucene takes 2 segments, and moves the content into a third, new one. Then the old segments are deleted from the disk. It means Lucene needs enough free space on the disk to create a segment the size of both segments it needs to merge.

A problem can arise when force merging a huge shard. If the shard size is > half of the disk size, you provably won't be able to fully merge it, unless most of the data is made of deleted documents.

How to shard our data?



As we can see if our daily ingestion rate for an index is quite high and our primary shards bit lower, we can run into trouble in a short time as all our shards for that index would've exhausted their individual capacities.

These factors should determine our primary shards and sharding in general:

1. Number of nodes (data nodes to be specific)
2. Disk space allocated on each of the nodes (in case of disk based shard allocation)
3. Daily ingestion rate (approximate) in the future

Other important things to note:

1. Data is always indexed into primary shards and primary shards cannot be changed once determined at time of index creation.
2. If you start out with 25 primary shards, it won't help if you go beyond 25 nodes in the cluster because we won't get more primary shards.
3. If you keep indexing documents, shards will grow beyond their size and this degrades search performance. In which case we either have to do expensive deletes or reindex with new primary shards parameter.

Suggestions:

1. Rather than running expensive deletes in big index, we can retire old index in one off-peak operation.
2. Multiple shards allow a better allocation between nodes.
3. Small shards on multiple nodes make the cluster recovery much faster when you lose a data node or shutdown the cluster.
4. Spreading smaller shards on lots of nodes might solve your memory management problems when running queries on a large data set.
5. We can different number of replicas for different indices, with more indices for new data to allow better search query performance.
6. It is safer to reindex smaller indices at a time rather than one big index. If we are already using more than 50% of available disc on the nodes the reindexing won't happen.
7. 10GB shards offers the most competitive balance between allocation speed, nodes balancing, and overall cluster management.
8. We can implement Hot-warm architecture : https://www.elastic.co/blog/implementing-hot-warm-cold-in-elasticsearch-with-index-lifecycle-management

Optimal approach for sharding:

With an average of 2GB for 1 million documents, for example, I'll use the following:

1. From 0 to 4 million documents per index: 1 shard.
2. From 4 to 5 million documents per index: 2 shards, so the index can still grow without causing too much problems in the future.
3. With more than 5 millions documents, (number of documents / 5 million) + 1 shard. The more data nodes you have, the better it works when you need to work with thousands of huge indexes (up to 300 million documents) in the same cluster.

Small script for resizing and moving things:

```
#!/bin/bash
for index in $(list of indexes); do
  documents=$(curl -XGET http://cluster:9200/${index}/_count 2>/dev/null |
cut -f 2 -d : | cut -f 1 -d ',')
```

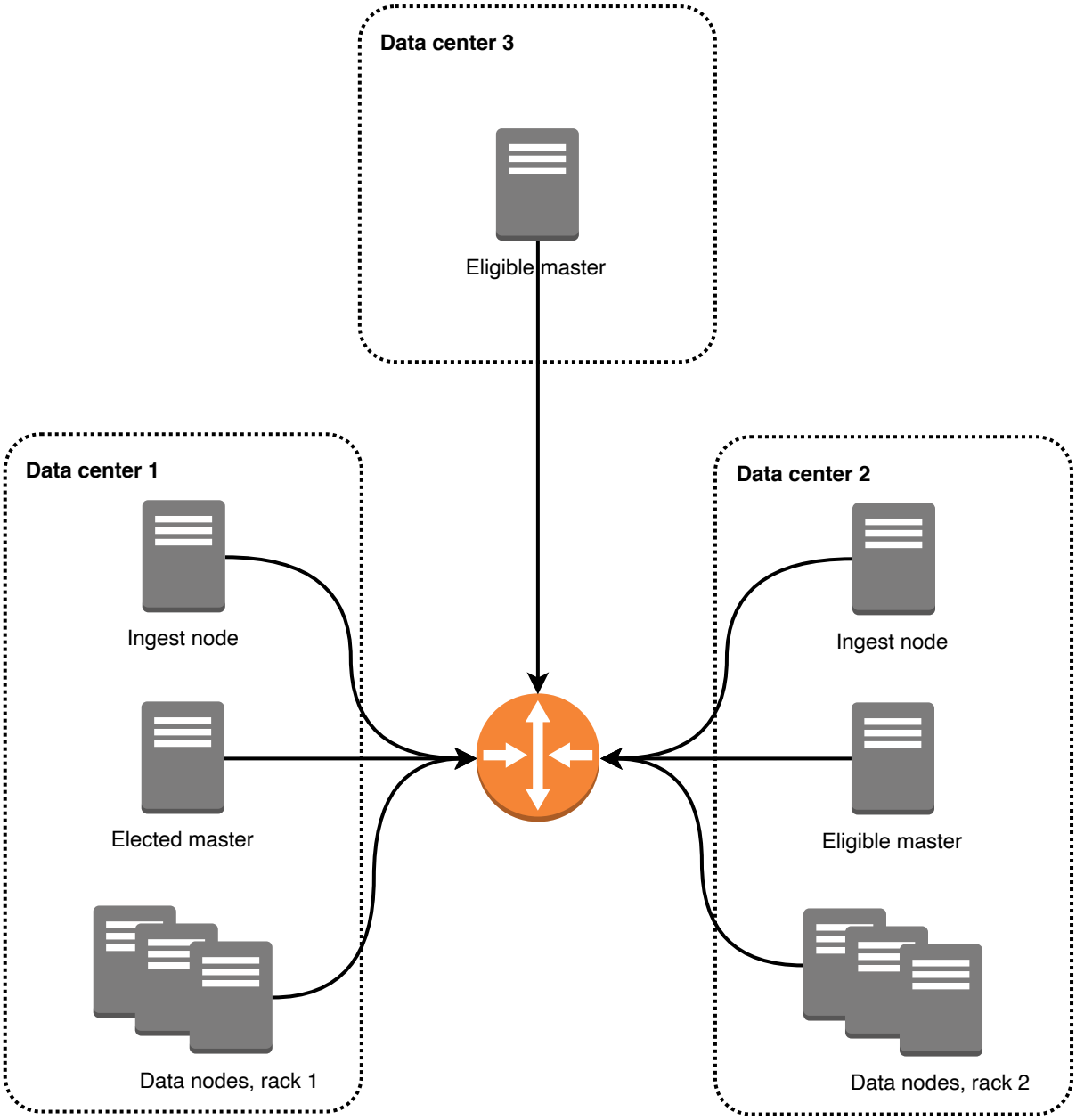
```
    if [ $counter -lt 4000000 ]; then
      shards=1
    elif [ $counter -lt 5000000 ]; then
        shards=2
    else
        shards=$(( $counter / 5000000 + 1))
    fi

    new_version=$(( $(echo ${index} | cut -f 1 -d _) + 1))
    index_name=$(echo ${index} | cut -f 2 -d _)

    curl -XPUT http://cluster:9200/${new_version}${index_name} -d '{
    "number_of_shards" : '${shards}'
    }'
  curl -XPOST http://cluster:9200/_reindex -d '{
    "source": {
      "index": "'${index}'"
    },
    "dest": {
      "index": "'${new_version}${index_name}'"
    }
  }'
  done
```

Once we've reindexed, we are ready to move the alias to right index and delete the old one.

Ensuring Fault tolerance:



Elasticsearch nodes come under 4 flavors:

1. Master nodes: Decides where to move data, reallocate missing data when a node leaves.
2. Ingest nodes: Pre-processes documents before actual documents are indexed. All nodes enable ingest by default.
3. Data nodes: Perform operations on data shards when queried/searched.
4. Coordinating nodes: Smart load balancers; gather data from various shards on different data during aggregations/search/CRUD.

When we create or change an Elasticsearch cluster, we can select between one and three availability zones as:

1. A single availability zone is suitable for testing and development
2. Two availability zones are suitable for production use (with a tiebreaker)
3. Three availability zones are great for mission critical environments

When deploying clusters in multiple availability zones, shard allocation awareness ensures that primary shards and their replica shards are spread across different zones to minimize the risk of losing all shard copies at the

same time.

Optimising shard allocation:

Once you use rack awareness, it might be interesting to optimise shard allocations using elasticsearch zones.

For example, if you have indices that are accessed more frequently than others, you might want to allocate more data nodes to those indices while the less frequently accessed indices have less resources allocated. This is extremely efficient with timestamped indices.

Let's say you have 20 data nodes, and 30 indices, you can create 3 zones. Allocate your 30 nodes to these zones according to the needed resources:

- new: 15 nodes
- general: 10 nodes
- old: 5 nodes

Every day, run a crontab to reallocate your indices to their new zone. For example, move a less accessed index into the "general" zone:

```
curl -XPUT "localhost:9200/index/_settings" -H 'Content-Type:
application/json' -d '
{
  "transient": {
    "cluster.routing.allocation.include._zone" : "general",
    "cluster.routing.allocation.exclude._zone" : "new,old"
  }
}
'
```

Hardware:

1. **Memory:**

- Elasticsearch file system storage has an important impact on the cluster performances. We can pick up niofs for file system storage.

```
The NIO FS type stores the shard index on the file system (maps to Lucene
NIOFSDirectory) using NIO. It allows multiple threads to read from the
same file concurrently.
```

- We might also want to commit the exact amount of memory you want to allocate to the heap at startup. This prevents the node from swapping when trying to allocate the memory it needs because no more memory is available.

```
boostrap.memory_lock (previously bootstrap.mlockall)
```

2. **Storage: (Pros & caveats of available options)**

- RAID0

  ☑ PROS:

```
  * RAID0 offers the maximum storage space on a single file system,
which is convenient when managing large shards.
  * Improves R/W performance as all disks are able to write in
parallel.
  * High capacity as the array can use all of the disk capacity for
storage.
```

  ☑ CAVEATS:

```
  * If a disk fails then all data on the entire array is lost, not
just the single disk.
  * As Elasticsearch indexes are made up of many shards, any index
that has a shard on a RAID 0 volume that suffers a disk failure can
also become corrupted if no other replicas exist.
```

- RAID1

  ☑ PROS:

```
  * High data protection as all data is mirrored.
  * Easy recovery when a disk fails -- just replacing the failed disk.
  * Elastic sees the array as a single disk.
```

  ☑ CAVEATS:

```
  * Effectively a 50% reduction in total read/write performance.
  * Low capacity, as the RAID 1 will take 50%
  of your total disk capacity for data redundancy.
```

Further tuning?

Depending on your throughput, you might need a large indexing buffer. The indexing buffer is a bunch of memory that stores the data to index.

Elasticsearch default index buffer is 10% of the memory allocated to the heap. But for heavy indexing operations, you might want to raise it to 30%, if not 40%.

```
indices:
  memory:
    index_buffer_size: "40%"
```

Please note by default ES allocates 90% heap for searching by default. So allocating 40% buffer size for indexing will mean 60% for search operations. Here we need to decide on optimal values for trade-off.

Finally, we might want to disable the store throttle if we're running on enough fast disks.

```
store:
  throttle.type: 'none'
```

One more thing: when we don't need data in realtime, but can afford waiting a bit, we can cut our cluster a little slack by raising the indices refresh interval as mentioned in the first section.

```
index:
  refresh_interval: "1m"
```

Trials and tribulations: (Execution on GCP VM instances)

Elastic node 1:

1. ssh into the elastic-node-1's VM instance.
2. Set the root directory as working directory
3. Execute these commands

```
mkdir opt
mkdir opt/disk1
mkdir opt/disk1/tools
mkdir opt/disk1/tools/elk
mkdir opt/disk1/tools/elk/logs
mkdir opt/disk1/tools/installers
mkdir opt/disk1/tools/installers/elastic
mkdir opt/disk1/tools/installers/java
mkdir opt/disk1/tools/elastic
sudo apt-get install default-jdk                              # Installs
JAVA -> prerequisite
gsutil cp gs://elk_installers/elastic/elasticsearch-7.3.0-linux-x86_64.tar
~/opt/disk1/tools/installers/elastic/    #Copies elasticsearch.tar.gz from
cloud storage
cd ~/opt/disk1/tools/elk
tar -xf ~/opt/disk1/tools/installers/elastic/elasticsearch-7.3.0-linux-
x86_64.tar
cp -r elasticsearch-7.3.0 elasticsearch
rm -rf elasticsearch-7.3.0
```

```
cat <<EOF > ~/opt/disk1/temp_elk_pwd.txt
"elastic"
EOF

sudo sysctl -w vm.max_map_count=262144                          # Mandatory
step to increase virtual memory for elasticsearcg

cd ~/opt/disk1/tools/elk/elasticsearch/bin/
./elasticsearch-keystore create                                 # Setup
bootstrap password -> necessary for elastic cluster
cat ~/opt/disk1/temp_elk_pwd.txt | ./elasticsearch-keystore add --stdin
"bootstrap.password"

cd ~/opt/disk1/tools/elk/elasticsearch/config
gsutil cp gs://elk_installers/elastic/jvm_new.options .
gsutil cp gs://elk_installers/elastic/elasticsearch-1.yml .
rm elasticsearch.yml
mv elasticsearch-1.yml elasticsearch.yml                        # Update
elasticsearch.yml with appropriate properties
rm jvm.options
mv jvm_new.options jvm.options                                  # Updated
heap size in jvm.options

cd ~/opt/disk1/
mkdir logs

cd ~/opt/disk1/tools/elk/
nohup elasticsearch/bin/elasticsearch > ~/opt/disk1/logs/sysout-elk.slog
2>&1 &             # start elasticsearch node
```

Elastic node 2:

1. ssh into the elastic-node-2's VM instance.
2. Set the root directory as working directory
3. Execute these commands

```
mkdir opt
mkdir opt/disk1
mkdir opt/disk1/tools
mkdir opt/disk1/tools/elk
mkdir opt/disk1/tools/elk/logs
mkdir opt/disk1/tools/installers
mkdir opt/disk1/tools/installers/elastic
mkdir opt/disk1/tools/installers/java
mkdir opt/disk1/tools/elastic
sudo apt-get install default-jdk                              # Installs
JAVA -> prerequisite
gsutil cp gs://elk_installers/elastic/elasticsearch-7.3.0-linux-x86_64.tar
~/opt/disk1/tools/installers/elastic/    #Copies elasticsearch.tar.gz from
cloud storage
```

```
cd ~/opt/disk1/tools/elk
tar -xf ~/opt/disk1/tools/installers/elastic/elasticsearch-7.3.0-linux-
x86_64.tar
cp -r elasticsearch-7.3.0 elasticsearch
rm -rf elasticsearch-7.3.0

cat <<EOF > ~/opt/disk1/temp_elk_pwd.txt
"elastic"
EOF

sudo sysctl -w vm.max_map_count=262144                          # Mandatory
step to increase virtual memory for elasticsearcg

cd ~/opt/disk1/tools/elk/elasticsearch/bin/
./elasticsearch-keystore create                                 # Setup
bootstrap password -> necessary for elastic cluster
cat ~/opt/disk1/temp_elk_pwd.txt | ./elasticsearch-keystore add --stdin
"bootstrap.password"

cd ~/opt/disk1/tools/elk/elasticsearch/config
gsutil cp gs://elk_installers/elastic/jvm_new.options .
gsutil cp gs://elk_installers/elastic/elasticsearch-2.yml .
rm elasticsearch.yml
mv elasticsearch-2.yml elasticsearch.yml                        # Update
elasticsearch.yml with appropriate properties
rm jvm.options
mv jvm_new.options jvm.options                                  # Updated
heap size in jvm.options

cd ~/opt/disk1/
mkdir logs

cd ~/opt/disk1/tools/elk/
nohup elasticsearch/bin/elasticsearch > ~/opt/disk1/logs/sysout-elk.slog
2>&1 &             # start elasticsearch node
```

Elastic node 3:

1. ssh into the elastic-node-3's VM instance.
2. Set the root directory as working directory
3. Execute these commands

```
mkdir opt
mkdir opt/disk1
mkdir opt/disk1/tools
mkdir opt/disk1/tools/elk
mkdir opt/disk1/tools/elk/logs
mkdir opt/disk1/tools/installers
mkdir opt/disk1/tools/installers/elastic
mkdir opt/disk1/tools/installers/java
mkdir opt/disk1/tools/elastic
```

```
sudo apt-get install default-jdk                                    # Installs
JAVA -> prerequisite
gsutil cp gs://elk_installers/elastic/elasticsearch-7.3.0-linux-x86_64.tar
~/opt/disk1/tools/installers/elastic/    #Copies elasticsearch.tar.gz from
cloud storage
cd ~/opt/disk1/tools/elk
tar -xf ~/opt/disk1/tools/installers/elastic/elasticsearch-7.3.0-linux-
x86_64.tar
cp -r elasticsearch-7.3.0 elasticsearch
rm -rf elasticsearch-7.3.0

cat <<EOF > ~/opt/disk1/temp_elk_pwd.txt
"elastic"
EOF

sudo sysctl -w vm.max_map_count=262144                              # Mandatory
step to increase virtual memory for elasticsearcg

cd ~/opt/disk1/tools/elk/elasticsearch/bin/
./elasticsearch-keystore create                                     # Setup
bootstrap password -> necessary for elastic cluster
cat ~/opt/disk1/temp_elk_pwd.txt | ./elasticsearch-keystore add --stdin
"bootstrap.password"

cd ~/opt/disk1/tools/elk/elasticsearch/config
gsutil cp gs://elk_installers/elastic/jvm_new.options .
gsutil cp gs://elk_installers/elastic/elasticsearch-3.yml .
rm elasticsearch.yml
mv elasticsearch-3.yml elasticsearch.yml                            # Update
elasticsearch.yml with appropriate properties
rm jvm.options
mv jvm_new.options jvm.options                                      # Updated
heap size in jvm.options

cd ~/opt/disk1/
mkdir logs

cd ~/opt/disk1/tools/elk/
nohup elasticsearch/bin/elasticsearch > ~/opt/disk1/logs/sysout-elk.slog
2>&1 &             # start elasticsearch node
```

Kibana

1. ssh into the kibana's VM instance.
2. Set the root directory as working directory
3. Execute these commands

```
mkdir opt
mkdir opt/disk1
mkdir opt/disk1/tools
mkdir opt/disk1/tools/elk
```

```
mkdir opt/disk1/tools/elk/logs
mkdir opt/disk1/tools/elk/logs/kibana
mkdir opt/disk1/tools/installers
mkdir opt/disk1/tools/installers/elastic
mkdir opt/disk1/tools/installers/java
mkdir opt/disk1/tools/elastic
sudo apt-get install default-jdk
gsutil cp gs://elk_installers/kibana/kibana-7.3.0-linux-x86_64.tar
~/opt/disk1/tools/installers/elastic/
cd ~/opt/disk1/tools/elk
tar -xf ~/opt/disk1/tools/installers/elastic/kibana-7.3.0-linux-x86_64.tar
cp -r kibana-7.3.0-linux-x86_64 kibana
rm -rf kibana-7.3.0-linux-x86_64

cd ~/opt/disk1/tools/elk/kibana/config
rm kibana.yml
gsutil cp gs://elk_installers/kibana/kibana.yml .

mkdir ~/opt/disk1/logs

cd ~/opt/disk1/tools/elk/
kibana/bin/kibana &                                                    #
Start kibana server
```