

TY B.Tech. (CSE) – II [2022-23]
5CS372 : Advanced Database System Lab.
Assignment No. 10

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Batch: T2

Title: Cassandra Clustering

Aim: To setup a multi-node Cassandra Cluster on single windows machine.

Introduction:

A graph database stores nodes and relationships instead of tables, or documents. Data is stored just like you might sketch ideas on a whiteboard. Your data is stored without restricting it to a pre-defined model, allowing a very flexible way of thinking about and using it.

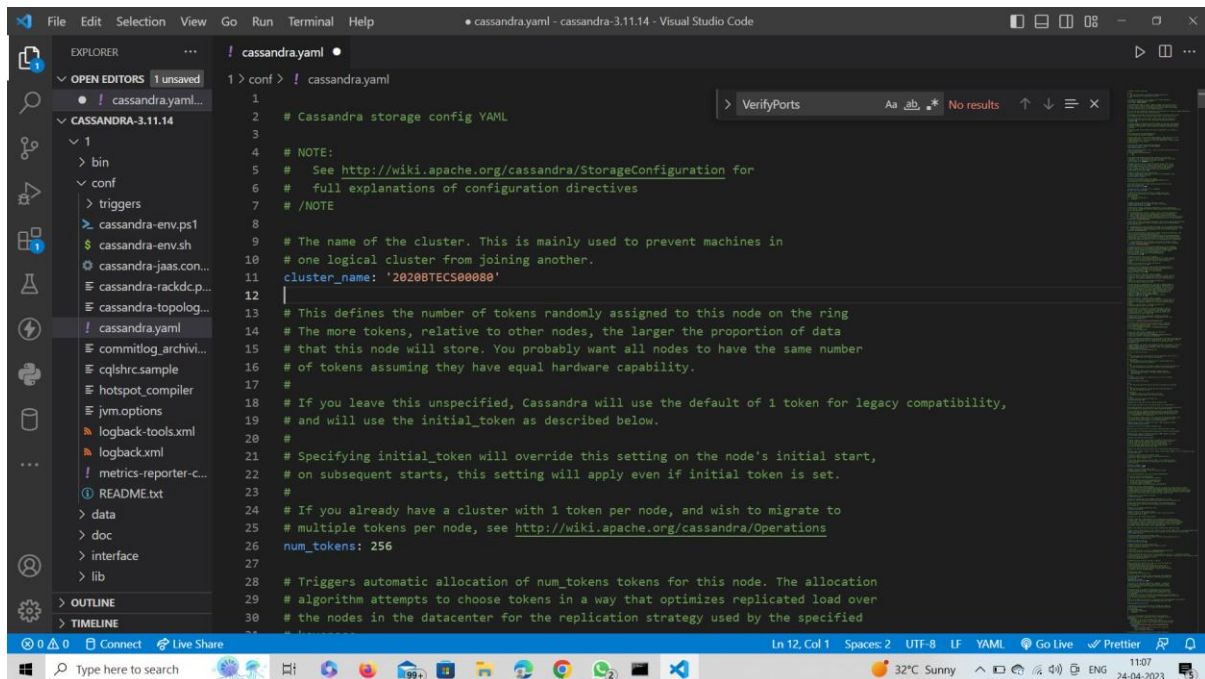
Theory:

Cassandra Clustering: In Cassandra, the data is distributed across a cluster. Additionally, a cluster may consist of a ring of nodes arranged in racks installed in data centers across geographical regions. At a more granular level, virtual nodes known as vnodes assign the data ownership to a physical machine.

Cassandra **uses either a simple partition key or a composite partition key for a table with a compound primary key, and defines clustering column(s).** A storage engine process, clustering sorts data based on the definition of the clustering columns within each partition.

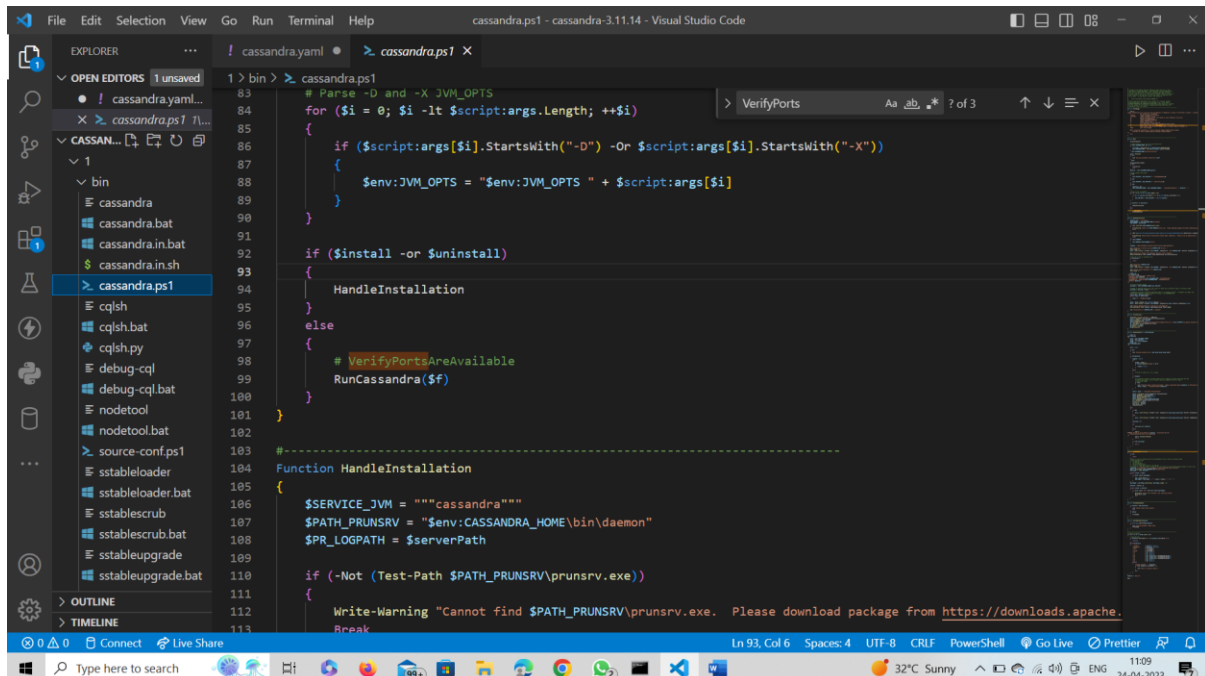
Procedure:

Name cluster:



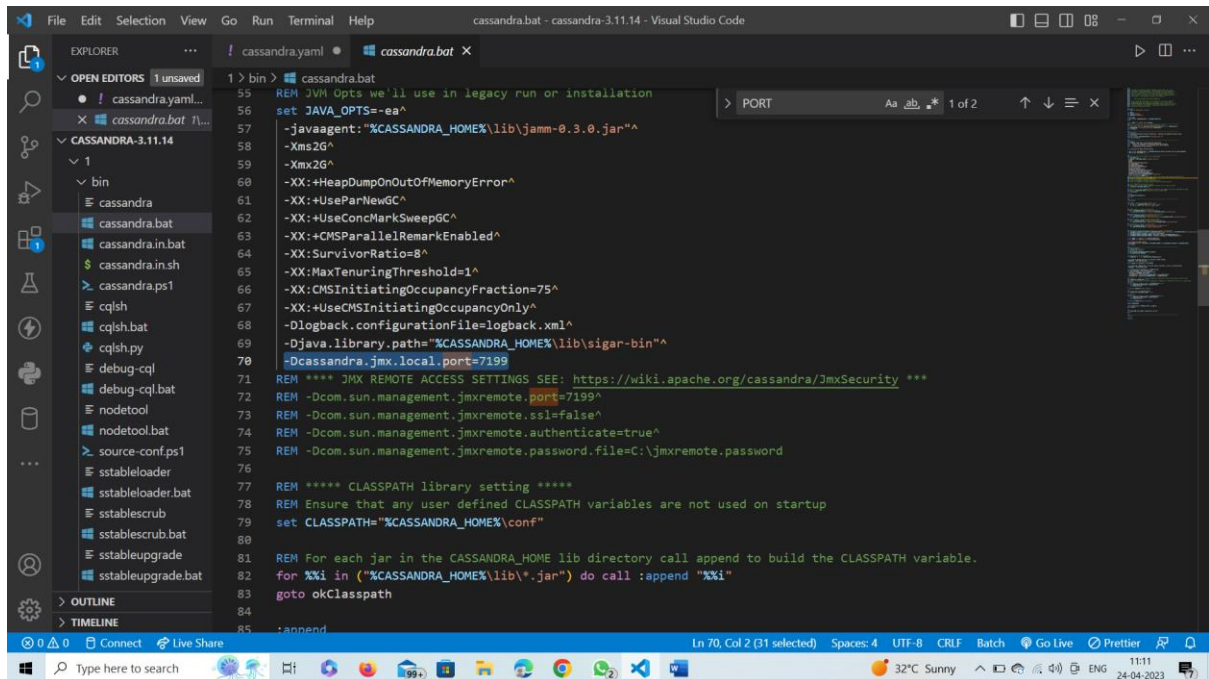
```
1 > conf > ! cassandra.yaml
2
3 # Cassandra storage config YAML
4
5 # NOTE:
6 # See http://wiki.apache.org/cassandra/StorageConfiguration for
7 # full explanations of configuration directives
8 # /NOTE
9
10 # The name of the cluster. This is mainly used to prevent machines in
11 # one logical cluster from joining another.
12 cluster_name: '2020BTECS00080'
13
14 # This defines the number of tokens randomly assigned to this node on the ring
15 # The more tokens, relative to other nodes, the larger the proportion of data
16 # that this node will store. You probably want all nodes to have the same number
17 # of tokens assuming they have equal hardware capability.
18 #
19 # If you leave this unspecified, Cassandra will use the default of 1 token for legacy compatibility,
20 # and will use the initial_token as described below.
21 #
22 # Specifying initial_token will override this setting on the node's initial start,
23 # on subsequent starts, this setting will apply even if initial token is set.
24 #
25 # If you already have a cluster with 1 token per node, and wish to migrate to
26 # multiple tokens per node, see http://wiki.apache.org/cassandra/Operations
27 num_tokens: 256
28
29 # Triggers automatic allocation of num_tokens tokens for this node. The allocation
30 # algorithm attempts to choose tokens in a way that optimizes replicated load over
31 # the nodes in the datacenter for the replication strategy used by the specified
```

Comment VerifyPortsAreAvailable:



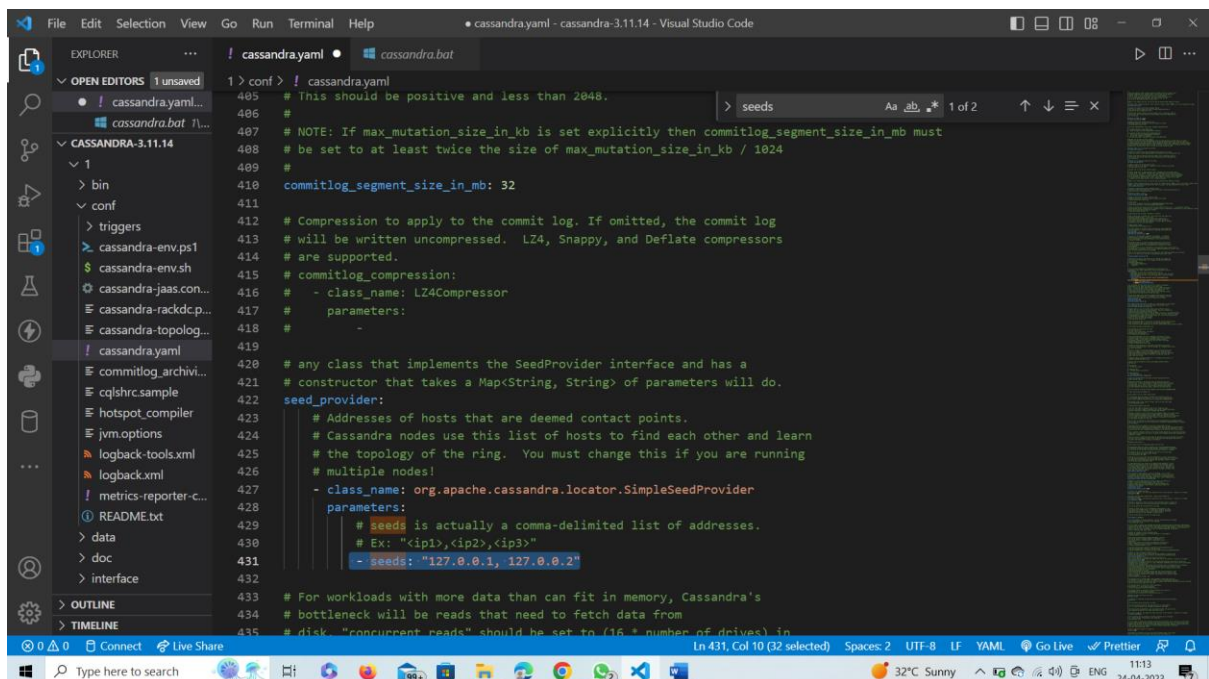
```
1 > bin > ! cassandra.ps1
2
3 # Parse -D and -X JVM_OPTS
4 for ($i = 0; $i -lt $Script:args.Length; ++$i)
5 {
6     if ($Script:args[$i].StartsWith("-D") -Or $Script:args[$i].StartsWith("-X"))
7     {
8         $env:JVM_OPTS = "$env:JVM_OPTS " + $Script:args[$i]
9     }
10 }
11
12 if ($install -or $uninstall)
13 {
14     HandleInstallation
15 }
16 else
17 {
18     # VerifyPortsAreAvailable
19     RunCassandra($f)
20 }
21
22 #-----
23 Function HandleInstallation
24 {
25     $SERVICE_JVM = ""cassandra""
26     $PATH_PRUNSRV = "$env:CASSANDRA_HOME\bin\daemon"
27     $PR_LOGPATH = $serverPath
28
29     if (-Not (Test-Path $PATH_PRUNSRV\prunsvr.exe))
30     {
31         Write-Warning "Cannot find $PATH_PRUNSRV\prunsvr.exe. Please download package from https://downloads.apache.org/cassandra/
32         Break
33     }
34 }
```

Port for 1st node is 7199:



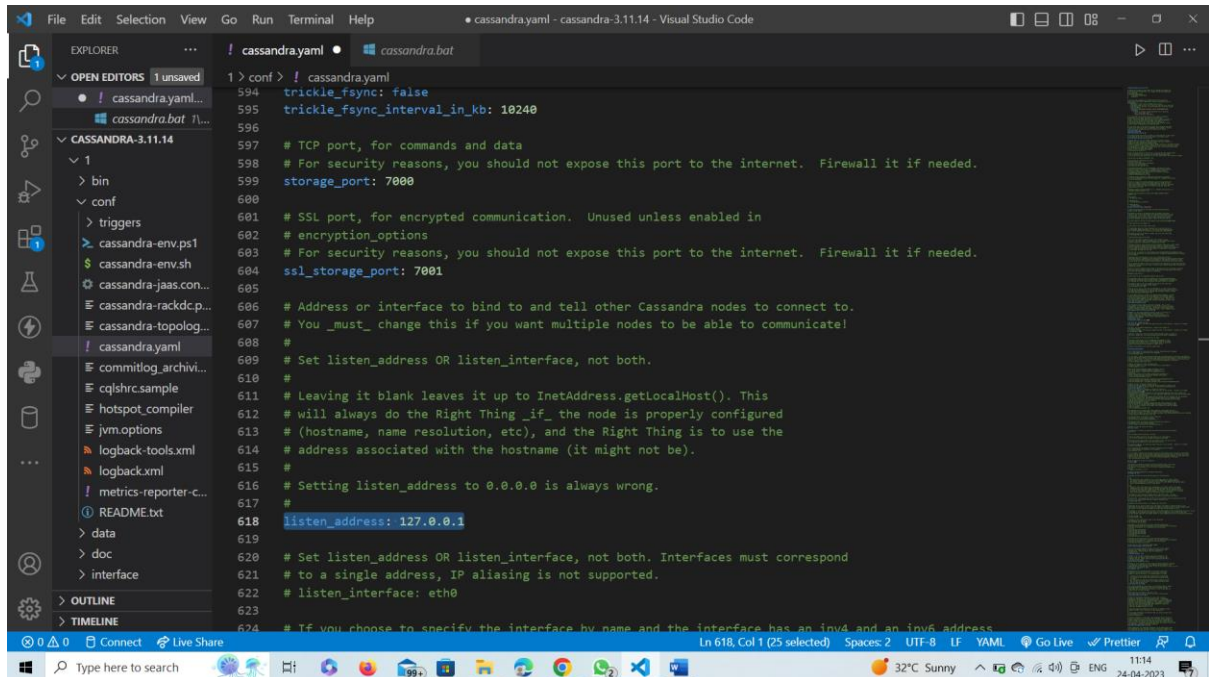
```
1 > bin > cassandra.bat
55 REM JVM Opts we'll use in legacy run or installation
56 set JAVA_OPTS=-ea^
57 -javaagent:"%CASSANDRA_HOME%\lib\jamm-0.3.0.jar"^
58 -Xms2G^
59 -Xmx2G^
60 -XX:+HeapDumpOnOutOfMemoryError^
61 -XX:+UseParNewGC^
62 -XX:+UseConcMarkSweepGC^
63 -XX:+CMSParallelRemarkEnabled^
64 -XX:SurvivorRatio=8^
65 -XX:MaxTenuringThreshold=1^
66 -XX:CMSInitiatingOccupancyFraction=75^
67 -XX:+UseCMSInitiatingOccupancyOnly^
68 -Dlogback.configurationFile=logback.xml^
69 -Djava.library.path="%CASSANDRA_HOME%\lib\sigar-bin"^
70 -Dcassandra.jmx.local.port=7199
71 REM *** JMX REMOTE ACCESS SETTINGS SEE: https://wiki.apache.org/cassandra/JmxSecurity ***
72 REM -Dcom.sun.management.jmxremote.port=7199^
73 REM -Dcom.sun.management.jmxremote.ssl=false^
74 REM -Dcom.sun.management.jmxremote.authenticate=true^
75 REM -Dcom.sun.management.jmxremote.password.file=C:\jmxremote.password
76
77 REM ***** CLASSPATH library setting *****
78 REM Ensure that any user defined CLASSPATH variables are not used on startup
79 set CLASSPATH="%CASSANDRA_HOME%\conf"
80
81 REM For each jar in the CASSANDRA_HOME lib directory call append to build the CLASSPATH variable.
82 for %xi in ("%CASSANDRA_HOME%\lib\*.jar") do call :append "%xi"
83 goto okClasspath
84
85 :append
```

Seeds : 127.0.0.1, 127.0.0.2



```
1 > conf > ! cassandra.yaml
405 # This should be positive and less than 2048.
406 #
407 # NOTE: If max_mutation_size_in_kb is set explicitly then commitlog_segment_size_in_mb must
408 # be set to at least twice the size of max_mutation_size_in_kb / 1024
409 #
410 commitlog_segment_size_in_mb: 32
411
412 # Compression to apply to the commit log. If omitted, the commit log
413 # will be written uncompressed. LZ4, Snappy, and Deflate compressors
414 # are supported.
415 # commitlog_compression:
416 #   - class_name: LZ4Compressor
417 #   parameters:
418 #     -
419
420 # any class that implements the SeedProvider interface and has a
421 # constructor that takes a Map<String, String> of parameters will do.
422 seed_provider:
423   # Addresses of hosts that are deemed contact points.
424   # Cassandra nodes use this list of hosts to find each other and learn
425   # the topology of the ring. You must change this if you are running
426   # multiple nodes!
427   - class_name: org.apache.cassandra.locator.SimpleSeedProvider
428     parameters:
429       # seeds is actually a comma-delimited list of addresses.
430       # Ex: "<ip1>,<ip2>,<ip3>"
431       - seeds: "127.0.0.1, 127.0.0.2"
432
433 # For workloads with more data than can fit in memory, Cassandra's
434 # bottleneck will be reads that need to fetch data from
435 # disk. "concurrent_reads" should be set to (16 * number of drives) in
```

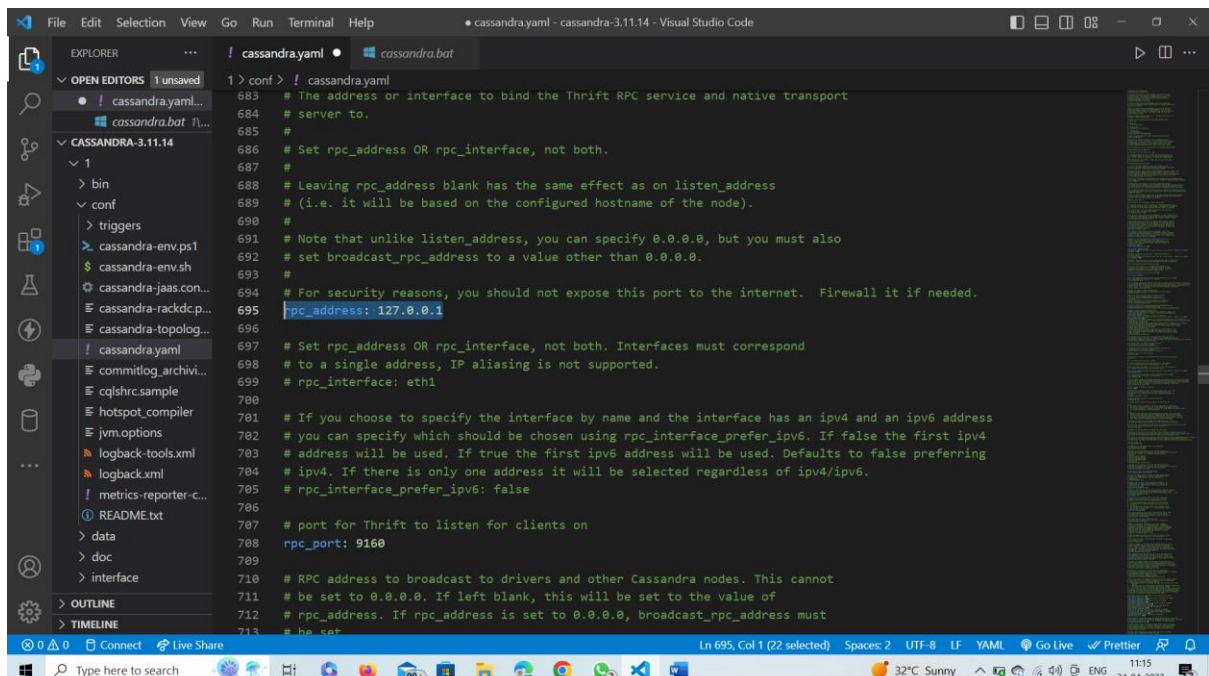
Listen address for 1st node: 127.0.0.1



The screenshot shows the Visual Studio Code editor with the `cassandra.yaml` file open. The file is part of the `CASSANDRA-3.11.14` project. The `listen_address` is set to `127.0.0.1`. The configuration includes various settings for the Cassandra node, such as `trickle_fsync`, `storage_port`, `ssl_storage_port`, and `listen_interface`.

```
1 > conf > ! cassandra.yaml
594 trickle_fsync: false
595 trickle_fsync_interval_in_kb: 10240
596
597 # TCP port, for commands and data
598 # For security reasons, you should not expose this port to the internet. Firewall it if needed.
599 storage_port: 7000
600
601 # SSL port, for encrypted communication. Unused unless enabled in
602 # encryption_options
603 # For security reasons, you should not expose this port to the internet. Firewall it if needed.
604 ssl_storage_port: 7001
605
606 # Address or interface to bind to and tell other Cassandra nodes to connect to.
607 # You _must_ change this if you want multiple nodes to be able to communicate!
608 #
609 # Set listen_address OR listen_interface, not both.
610 #
611 # Leaving it blank leaves it up to InetAddress.getLocalHost(). This
612 # will always do the Right Thing _if_ the node is properly configured
613 # (hostname, name resolution, etc), and the Right Thing is to use the
614 # address associated with the hostname (it might not be).
615 #
616 # Setting listen_address to 0.0.0.0 is always wrong.
617 #
618 listen_address: 127.0.0.1
619
620 # Set listen_address OR listen_interface, not both. Interfaces must correspond
621 # to a single address, IP aliasing is not supported.
622 # listen_interface: eth0
623
624 # If you choose to specify the interface by name and the interface has an ipv4 and an ipv6 address
```

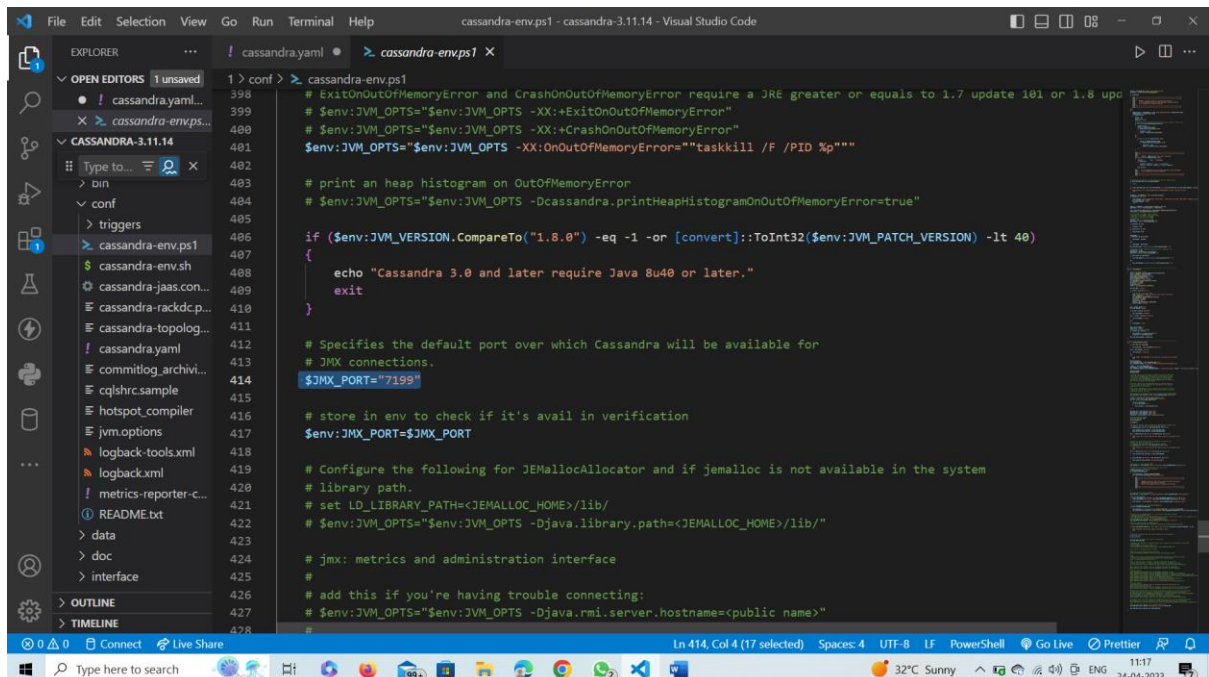
Rpc address of 1st node: 127.0.0.1



The screenshot shows the Visual Studio Code editor with the `cassandra.yaml` file open. The `rpc_address` is set to `127.0.0.1`. The configuration includes various settings for the Cassandra node, such as `rpc_interface`, `rpc_port`, and `broadcast_rpc_address`.

```
683 # The address or interface to bind the Thrift RPC service and native transport
684 # server to.
685 #
686 # Set rpc_address OR rpc_interface, not both.
687 #
688 # Leaving rpc_address blank has the same effect as on listen_address
689 # (i.e. it will be based on the configured hostname of the node).
690 #
691 # Note that unlike listen_address, you can specify 0.0.0.0, but you must also
692 # set broadcast_rpc_address to a value other than 0.0.0.0.
693 #
694 # For security reasons, you should not expose this port to the internet. Firewall it if needed.
695 rpc_address: 127.0.0.1
696
697 # Set rpc_address OR rpc_interface, not both. Interfaces must correspond
698 # to a single address, IP aliasing is not supported.
699 # rpc_interface: eth1
700
701 # If you choose to specify the interface by name and the interface has an ipv4 and an ipv6 address
702 # you can specify which should be chosen using rpc_interface_prefer_ipv6. If false the first ipv4
703 # address will be used. If true the first ipv6 address will be used. Defaults to false preferring
704 # ipv4. If there is only one address it will be selected regardless of ipv4/ipv6.
705 # rpc_interface_prefer_ipv6: false
706
707 # port for Thrift to listen for clients on
708 rpc_port: 9160
709
710 # RPC address to broadcast to drivers and other Cassandra nodes. This cannot
711 # be set to 0.0.0.0. If left blank, this will be set to the value of
712 # rpc_address. If rpc_address is set to 0.0.0.0, broadcast_rpc_address must
713 # be set
```


\$JMX_PORT="7199"



```
398 # ExitOnOutOfMemoryError and CrashOnOutOfMemoryError require a JRE greater or equals to 1.7 update 101 or 1.8 update 102
399 # $env:JVM_OPTS="$env:JVM_OPTS -XX:+ExitOnOutOfMemoryError"
400 # $env:JVM_OPTS="$env:JVM_OPTS -XX:+CrashOnOutOfMemoryError"
401 $env:JVM_OPTS="$env:JVM_OPTS -XX:OnOutOfMemoryError='taskkill /F /PID %p'"
402
403 # print an heap histogram on OutOfMemoryError
404 # $env:JVM_OPTS="$env:JVM_OPTS -Dcassandra.printHeapHistogramOnOutOfMemoryError=true"
405
406 if ($env:JVM_VERSION.CompareTo("1.8.0") -eq -1 -or [convert]::ToInt32($env:JVM_PATCH_VERSION) -lt 40)
407 {
408     echo "Cassandra 3.0 and later require Java 8u40 or later."
409     exit
410 }
411
412 # Specifies the default port over which Cassandra will be available for
413 # JMX connections.
414 $JMX_PORT="7199"
415
416 # store in env to check if it's avail in verification
417 $env:JMX_PORT=$JMX_PORT
418
419 # Configure the following for JEMallocAllocator and if jemalloc is not available in the system
420 # library path.
421 # set LD_LIBRARY_PATH=<JEMALLOC_HOME>/lib/
422 # $env:JVM_OPTS="$env:JVM_OPTS -Djava.library.path=<JEMALLOC_HOME>/lib/"
423
424 # jmx: metrics and administration interface
425 #
426 # add this if you're having trouble connecting:
427 # $env:JVM_OPTS="$env:JVM_OPTS -Djava.rmi.server.hostname=<public name>"
428 #
```

Make same changes in other 2 nodes.

Just following are node specific changes.

2nd node

:

Port for 2nd node is 7299:

Listen address for 2nd node: 127.0.0.2

Rpc address of 2nd node: 127.0.0.2

\$JMX_PORT="7299"

3rd node:

Port for 3rd node is 7399:

Listen address for 3rd node: 127.0.0.3

Rpc address of 3rd node: 127.0.0.3

\$JMX_PORT="7399"

Starting node 1:

```
C:\Windows\System32\cmd.exe - cassandra -f
Microsoft Windows [Version 10.0.19044.2846]
(c) Microsoft Corporation. All rights reserved.

C:\cassandra-3.11.14\bin>cassandra -f
WARNING! Powershell script execution unavailable.
Please use 'powershell Set-ExecutionPolicy Unrestricted'
on this user-account to run cassandra with fully featured
functionality on this platform.
Starting with legacy startup options
Starting Cassandra Server
INFO [main] 2023-04-24 11:38:33,296 YamlConfigurationLoader.java:93 - Configuration location: file:/C:/cassandra-3.11.14/conf/cassandra.yaml
INFO [main] 2023-04-24 11:38:33,937 Config.java:555 - Node configuration:[allocate_tokens_for_keyspace=null; allow_insecure_udfs=false; allow_insecure_udfs=false; authenticator=AllowAllAuthenticator; authorizer=AllowAllAuthorizer; auto_bootstrap=true; auto_snapshot=true; back_pressure_enabled=false; back_pressure_strategy=org.apache.cassandra.net.RateBasedBackPressure(high_ratio=0.9, factor=5, flow=FAST); batch_size_fail_threshold_in_kb=50; batch_size_warn_threshold_in_kb=5; broadcast_replay_throttle_in_kb=1024; broadcast_rpc_address=null; broadcast_rpc_address=null; buffer_pool_use_heap_if_exhausted=true; cache_load_timeout_in_seconds=30; cas_contention_timeout_in_ms=1000; cdc_enabled=false; cdc_free_space_check_interval_ms=256; cdc_raw_directory=null; cdc_total_space_in_mb=0; check_for_duplicate_rows_during_compaction=true; check_for_duplicate_rows_during_reads=true; client_encryption_options=<REDACTED>; cluster_name=Test Cluster; column_index_cache_size_in_kb=2; column_index_size_in_kb=64; commit_failure_policy=stop; commitlog_compression=null; commitlog_directory=null; commitlog_max_compression_buffers_in_pool=3; commitlog_periodic_queue_size=1; commitlog_segment_size_in_mb=32; commitlog_sync_periodic; commitlog_sync_batch_window_in_ms=null; c commitlog_sync_period_in_ms=10000; commitlog_total_space_in_mb=null; compaction_large_partition_warning_threshold_mb=100; compaction_throughput_mb_per_sec=16; concurrent_compactors=null; concurrent_counter_writes=32; concurrent_materialized_view_writes=32; concurrent_reads=32; concurrent_replicates=null; concurrent_writes=32; counter_cache_keys_to_save=2147483647; counter_cache_save_period=7200; counter_cache_size_in_mb null; counter_write_request_timeout_in_ms=5000; credentials_cache_max_entries=1000; credentials_update_interval_in_ms=1; credentials_validity_in_ms=2000; cross_node_timeout=false; data_file_directories=[Ljava.lang.String;@4ffe7673]; disk_access_mode=auto; disk_failure_policy=stop; disk_optimization_estimate_percentile=0.95; disk_optimization_page_cross_chance=0.1; disk_optimization_strategy=ssd; dynamic_snitch=true; dynamic_snitch_badness_threshold=0.1; dynamic_snitch_reset_interval_in_ms=600000; dynamic_snitch_update_interval_in_ms=100; enable_drop_compact_storage=false; enable_materialized_views=true; enable_sasi_indexes=true; enable_scripted_user_defined_functions=false; enable_user_defined_functions=false; enable_user_defined_functions_threads=true; encryption_options=<REDACTED>; endpoint_snitch=SimpleSnitch; file_cache_round_up=null; file_cache_size_in_mb=null; force_new_prepared_statement_behaviour=false; gc_log_threshold_in_ms=200; gc_warn_threshold_in_ms=1000; hinted_handoff_disabled_datacenters=[]; hinted_handoff_enabled=true; hinted_handoff_throttle_in_kb=1024; hints_compression=null; hints_directory=null; hints_flush_period_in_ms=10000; incremental_backups=false; index_interval=null; index_summary_capacity_in_mb=null; index_summary_resize_interval_in_minutes=60; initial_token=null; inter_dc_stream_throughput_outbound_megabits_per_sec=200; inter_dc_tcp_nodelay=false; internode_authenticator=null; internode_compression=dc; internode_recv_buff_size_in_bytes=0; internode_send_buff_size_in_bytes=0; key_cache_keys_to_save=2147483647; key_cache_save_period=14400; key_cache_size_in_mb=null; listen_address=127.0.0.1; listen_interface=null; listen_interface_prefer_ipv6=false; listen_on_broadcast_address=false; max_hint_window_in_ms=10000000; max_hints_delivery_threads=2; max_hints_file_size_in_mb=128; max_mutation_size_in_kb=128; max_streaming_retries=3; max_value_size_in_mb=256; memtable_allocation_type=heap_buffers; memtable_cleanup_threshold=null; memtable_flush_writers=8; memtable_heap_space_in_mb=null; memtable_offheap_space_in_mb=null; min_free_space_per_drive_in_mb=50; native_transport_flush_in_batches_legacy=true; native_transport_max_concurrent_connections=1; native_transport_max_inflight_mb=100; native_transport_max_outstanding_requests_in_bytes=1; native_transport_max_outstanding_requests_in_bytes_per_ip=1; native_transport_max_protocol_version=2147483647; native_transport_max_threads=128; native_transport_port=9042; native_transport_port_ssl=null; num_tokens=256; otc_backlog_expiration_interval_ms=200; otc_coalescing_enough_coalesced_messages=8; otc_coalescing_strategy=DISABLED; otc_coalescing_window_size=200; partitioner=org.apache.cassandra.dht.Murmur3Partitioner; permissions_cache_max_entries=1000; permissions_update_interval_in_ms=1; permissions_validity_in_ms=2000; phi_convict_threshold=8.0; prepared_statements_cache_size_mb=null; range_repair_range_repair_timeout_in_ms=5000; read_request_timeout_in_ms=5000; repair_session_max_repair_depth=12; request_scheduler=org.apache.cassandra.scheduler.NoScheduler; request_scheduler_id=null; request_scheduler_options=null; request_timeout_in_ms=10000; role_manager=CassandraRoleManager; roles_cache_max_entries=1000; roles_update_interval_in_ms=1; roles_validity_in_ms=2000; row_cache_class_name=org.apache.cassandra.cache.OHCProvider; row_cache_keys_to_save=2147483647; row_cache_save_period=0; row_cache_size_in_mb=null; rpc_address=127.0.0.1; rpc_interface=null; rpc_interface_prefer_ipv6=false; rpc_keepalive=true; rpc_listen_backlog=50; rpc_max_threads=2147483647; rpc_min_threads=16; rpc_port=9160; rpc_recv_buff_size_in_bytes=null; rpc_send_buff_size_in_bytes=null; rpc_server_type=sync; saved_caches_directory=null; sse_provider=org.apache.cassandra.locator.SimpleSeedProvider[seeds=127.0.0.1, 127.0.0.1]; server_encryption_options=<REDACTED>; slow_query_log_timeout_in_ms=300; snapshot_before_compaction=false; snapshot_on_duplicate_row_detection=false; ssl_storage_port=7001; stable_preemptive_open_interval_in_ms=50; start_native_transport=true; start_rpc=false; storage_port=7000; stream_throughput_outbound_megabits_per_sec=200; streaming_keep_alive_period_in_secs=300; streaming_socket_timeout_in_ms=86400000; thrift_framed_transport_size_in_mb=15; thrift_max_message_length_in_mb=16; thrift_prepared_statements_cache_size_mb=null; tombstone_expiry_threshold=10000; tombstone_warn_threshold=1000; tracetype_query_ttl=86400; tracetype_repair_ttl=604800; transient_data_encryption_options=org.apache.cassandra.config.TransparentDataEncryptionOptions<2>B05C908; trickle_fsync=false; trickle_fsync_interval_in_kb=10240; truncate_request_timeout_in_ms=60000; unlogged_batch_cross_partitions_warn_threshold=10; user_defined_function_fail_timeout=1500; user_defined_f function_max_timeout=500; user_function_timeout_policy=if; window_timer_interval=1; write_request_timeout_in_ms=2000]
INFO [main] 2023-04-24 11:38:33,938 DatabaseDescriptor.java:181 - DiskAccessMode 'auto' determined to be mmap, indexAccessMode is mmap
INFO [main] 2023-04-24 11:38:33,943 DatabaseDescriptor.java:439 - Global memtable on-heap threshold is enabled at 495MB
INFO [main] 2023-04-24 11:38:33,945 DatabaseDescriptor.java:443 - Global memtable off-heap threshold is enabled at 495MB
INFO [main] 2023-04-24 11:38:34,132 RateBasedBackPressure.java:123 - Initialized back-pressure with high ratio: 0.9, factor: 5, flow: FAST, window size: 2000.
INFO [main] 2023-04-24 11:38:34,133 DatabaseDescriptor.java:721 - Back pressure is disabled with strategy org.apache.cassandra.net.RateBasedBackPressure(high_ratio=0.9, factor=5, flow=FAST).
INFO [main] 2023-04-24 11:38:34,291 CassandraDaemon.java:690 - Hostname: LAPTOP-PL6NE83E
```

Node 1 started

```
Select C:\Windows\System32\cmd.exe - cassandra -f
INFO [main] 2023-04-24 11:39:10,241 TokenMetadata.java:507 - Updating topology for /127.0.0.1
INFO [main] 2023-04-24 11:39:10,285 StorageService.java:118 - Using saved tokens [127.0.0.1/127.0.0.1, 1180556800062457189, -1208151023691724028, -1544863911024741599, -159614076007118970, -1598461075663991, -160790343517626088, -1721170337230152434, -17407805578288041143, -178904099265246841, -184943216231417348, -18571478015568288, -195580286267861835, -2270936697689643805, -2276224002761179716, -22944154429299762, -2311030955238234245, -23232131270543408112, -2415246103414105569, -242019245994427374, -2453364297758124743, -2501108906005300751, -2585502715290804598, -2678305315291794592, -27146223226524330, -2779126499232013661, -288771459245176888, -296582484313191123, -321394707361188043, -3281727512984716288, -337341060896850473, -3392170670369307410, -341362028179418155, -354359466524295831, -357997252785224464, -361513958973226406, -3676112611485379897, -3705705070939923292, -3771190918640372525, -3818425205091707198, -3826629585919171259, -3854613474548953099, -3875903689896064625, -3899517606266808586, -409119738339732809, -40977775388592279, -410301312433080786, -4151738650939737307, -4185110416213273054, -431613501834556017, -4392351097182359000, -4410934214030866065, -44129687037912346, -4460284372800019261, -4654831352368430715, -4725775334106466136, -474073840628536197, -4813962137420103873, -49137800770017224825, -503496208289240317, -5079292767418805461, -5118913160396812371, -52378881873076558290620, -70724175387627290368, -710560568624274227, -713840163877923531, -715597786014833054, -7356010043051048700, -7366033566195686580, -744840029564835758, -7470809206345775016, -7580913685981185757, -761763343444384582, -7706677700104390810, -7826188756274495995, -7995454304531013376, -8008723319775607303, -801899195649870722, -8017694509235796575, -802484204288241083, -8181736049522724952, -8184324428398670884, -8216583859245135742, -8264818932590621400, -82893788651846372, -8324738343101247622, -8405461003257482085, -8597529190113150775, -8676150177582356059, -8802155942616405954, -8848639526295898125, -88540226459899162, -9002801517430371091, -901726039910356400, -920228076187858071, -920426369013552400, -103703755888633786, -120081000408185568, -125758038118110842, -12961094965659535, -14071661285820725, -152985722842397332, -1533404952721011784, -158498428830246777, -159379793244743267, -1661841359451858046, -173053597288175390, -176086229218849517, -1763415184537640152, -177471755132041196, -186788868768081932, -1887036558290620, -2039150293558864791, -21821368072163959, -216989866445119511, -2270740729513417309, -2338673635372384944, -2386579923504446879, -243934134368942391, -2443922795983941809, -2476858470604376216, -249559257202302406, -2575621232119635078, -260130517952973171, -265891367289651562, -2712164347010898941, -2789820884387113612, -3070419993136404879, -325613157078385611, -3388444166432223656, -345126815400955224, -34951009930395253, -349514400352579017, -3561430719260121, -356024089859925371, -3582957540700989884, -3626213274199042637, -374687285628828002, -384884821759132154, -397132173378238473, -412361702136079309, -426601009691230640, -4312560180934163644, -43197540108396441, -441211632788278080, -456888376632715095, -462258420691215592, -481133690220000624, -496540837263277047, -5035035311202430, -511656719908726992, -513579738590858066, -521028137176845229, -531018782063798264, -538278175118901547, -547809338825163636, -5576613685398628440, -5676297802435240839, -56873968333962687, -572518931354444249, -572665009787701778, -5757627126013991050, -602616848232452435, -60772326758167409, -6091096825033223297, -6098986360348095664, -6095815404708407154, -6095119095476891104, -7123140211994599260, -7173650456453934402, -73635937501498688, -73845255398801737, -740817620638829217, -740817961460917740, -754252987523973543, -7545325963874551256, -765005506615667851, -779178110830260, -788226345469328639, -78837381817591267, -790178856675895663, -810071014621627270, -8172127292090829, -820790305579993014, -835967711306957854, -840172208086495983, -8439326742725401457, -847479680436691405, -85007972024228270, -851470408710241737, -859836274034941613, -85963436671989844, -866759554324203136, -8692937682156234047, -871925348689025772, -871926091509711179, -8737309385901195538, -877329043529279870, -8832376110713277556, -891042278983086657, -89494565884102957, -907339923902512461, -9077345136198544206, -9088087914319910557, -917956161871912745]
INFO [main] 2023-04-24 11:39:10,313 StorageService.java:1568 - JOINING: Finish joining ring
INFO [main] 2023-04-24 11:39:10,417 StorageService.java:2484 - Node /127.0.0.1 State Jump to NORMAL
INFO [main] 2023-04-24 11:39:10,702 NativeTransportService.java:73 - Netty using Java NIO event loop
INFO [main] 2023-04-24 11:39:10,796 Server.java:158 - Using Netty Version: [netty-buffer-netty-buffer-4.0.44.Final.452812a, netty-codec-netty-codec-4.0.44.Final.452812a, netty-codec-haproxy-netty-codec-haproxy-4.0.44.Final.452812a, netty-codec-http-netty-codec-http-4.0.44.Final.452812a, netty-codec-socks-netty-codec-socks-4.0.44.Final.452812a, netty-common-netty-common-4.0.44.Final.452812a, netty-handler-netty-handler-4.0.44.Final.452812a, netty-tcnative-netty-tcnative-1.1.33.Fork2b, netty-transport-netty-transport-4.0.44.Final.452812a, netty-transport-native-epoll-netty-transport-native-epoll-4.0.44.Final.452812a, netty-transport-native-kqueue-netty-transport-native-kqueue-4.0.44.Final.452812a, netty-transport-udt-netty-transport-udt-4.0.44.Final.452812a]
INFO [main] 2023-04-24 11:39:11,005 CassandraDaemon.java:564 - Not starting RPC server as requested. Use JMX (StorageService.startRPCServer()) or nodetool (enablethrift) to start it
INFO [main] 2023-04-24 11:39:11,005 CassandraDaemon.java:650 - Startup complete
```


Starting node 2:

```
C:\Windows\System32\cmd.exe - cassandra -f
Microsoft Windows [Version 10.0.19044.2846]
(c) Microsoft Corporation. All rights reserved.

C:\cassandra-3.11.14\2>bin\cassandra -f
WARNING! Powershell script execution unavailable.
Please use 'powershell Set-ExecutionPolicy Unrestricted'
on this user-account to run cassandra with fully featured
functionality on this platform.
Starting with legacy startup options
Starting Cassandra server
INFO [main] 2023-04-24 11:42:38,582 YamlConfigurationLoader.java:93 - Configuration location: file:/C:/cassandra-3.11.14/2/conf/cassandra.yaml
INFO [main] 2023-04-24 11:42:39,521 Config.java:555 - Node configuration:[allocate_tokens_for_keyspace=null; allow_extra_insecure_udfs=false; allow_insecure_udfs=false; authenticator=AllowAllAuthenticator; auth
orizer=AllowAllAuthorizer; auto_bootstrap=true; auto_snapshot=true; back_pressure_enabled=false; back_pressure_strategy=org.apache.cassandra.net.RateBasedBackPressure(high_ratio=0.9, factor=5, flow=FAST); batch
_size_fall_threshold_in_kb=50; batch_size_warn_threshold_in_kb=5; batchlog_replay_throttle_in_kb=1024; broadcast_rpc_address=null; buffer_pool_use_heap_if_exhausted=true; cache_load_timeout
_in_seconds=30; cas_contention_timeout_in_ms=1000; cdc_enabled=false; cdc_free_space_check_interval_ms=250; cdc_log_directory=null; cdc_total_space_in_mb=0; check_for_duplicate_rows_during_compaction=true; check_f
or_duplicate_rows_during_reads=true; client_encryption_options=<REDACTED>; cluster_name=Test Cluster; column_index_cache_size_in_kb=2; column_index_size_in_kb=64; commit_failure_policy=stop; commitlog_compressio
n=null; commitlog_directory=null; commitlog_max_compression_buffers_in_pool=3; commitlog_periodic_queue_size=1; commitlog_segment_size_in_mb=32; commitlog_sync=periodic; commitlog_sync_batch_window_in_ms=NaN; c
ommitlog_sync_period_in_ms=10000; commitlog_total_space_in_mb=null; compaction_large_partition_warning_threshold_mb=100; compaction_throughput_mb_per_sec=16; concurrent_compactors=null; concurrent_counter_writes
=32; concurrent_materialized_view_writes=32; concurrent_reads=32; concurrent_replicas=null; concurrent_writes=32; counter_cache_keys_to_save=2147483647; counter_cache_save_period=7200; counter_cache_size_in_mb
=null; counter_write_request_timeout_in_ms=5000; credentials_cache_max_entries=1000; credentials_update_interval_in_ms=-1; credentials_validity_in_ms=2000; cross_node_timeout=false; data_file_directories=[Ljava
.lang.String;@4fe767f3]; disk_access_mode=auto; disk_failure_policy=stop; disk_optimization_estimate_percentile=0.95; disk_optimization_page_cross_chance=0.1; disk_optimization_strategy=ssd; dynamic_snitch=true; d
ynamic_snitch_badness_threshold=0.1; dynamic_snitch_reset_interval_in_ms=600000; dynamic_snitch_update_interval_in_ms=100; enable_drop_compact_storage=false; enable_materialized_views=true; enable_sasi_indexes=t
rue; enable_scripted_user_defined_functions=false; enable_user_defined_functions=false; enable_user_defined_functions_threads=true; encryption_options=<REDACTED>; endpoint_snitch=SimpleSnitch; file_cache_round_u
p=null; file_cache_size_in_mb=null; force_new_prepared_statement_behaviour=false; gc_log_threshold_in_ms=200; gc_warn_threshold_in_ms=1000; hinted_handoff_disabled_datacenters=[]; hinted_handoff_enabled=true; hi
nted_handoff_throttle_in_kb=1024; hints_compression=null; hints_directory=null; hints_flush_period_in_ms=10000; incremental_backups=false; index_interval=null; index_summary_capacity_in_mb=null; index_summary_re
size_interval_in_minutes=60; initial_token=null; inter_dc_stream_throughput_outbound_megabits_per_sec=200; inter_dc_tcp_nodelay=false; internode_authenticator=null; internode_compression=dc; internode_recv_buff
_size_in_bytes=0; internode_send_buff_size_in_bytes=0; key_cache_keys_to_save=2147483647; key_cache_size_in_mb=null; listen_address=127.0.0.2; listen_interface=null; listen_interface_prefer_ipv6=false; listen_on_broadc
ast_address=false; max_hint_window_in_ms=10000000; max_hints_delivery_threads=2; max_hints_file_size_in_mb=128; max_mutation_size_in_kb=null; max_streaming_retries=3; max_value
_size_in_mb=256; memtable_allocation_type=heap_buffers; memtable_cleanup_threshold=null; memtable_flush_writers=0; memtable_heap_space_in_mb=null; memtable_offheap_space_in_mb=null; min_free_space_per_drive_in_m
b=50; native_transport_flush_in_batches_legacy=true; native_transport_max_concurrent_connections=-1; native_transport_max_concurrent_connections_per_ip=-1; native_transport_max_concurrent_requests_in_bytes=-1; n
ative_transport_max_concurrent_requests_in_bytes_per_ip=-1; native_transport_max_frame_size_in_mb=256; native_transport_max_negotiable_protocol_version=2147483648; native_transport_max_threads=128; native_trans
port_port=9042; native_transport_port_ssl=null; max_tokens=256; otc_backlog_expiration_interval_ms=200; otc_coalescing_enough_coalesced_messages=8; otc_coalescing_strategy=DISABLED; otc_coalescing_window_us=200;
partitions_per_org.apache.cassandra.dht.NumericalPartitioner; permissions_cache_max_entries=1000; permissions_update_interval_in_ms=-1; permissions_validity_in_ms=2000; phi_convict_threshold=8; prepared_statements
_cache_size_mb=null; range_request_timeout_in_ms=10000; read_request_timeout_in_ms=5000; repair_session_max_tree_depth=18; request_scheduler=org.apache.cassandra.scheduler.NoScheduler; request_scheduler_id=null;
request_scheduler_options=null; request_timeout_in_ms=10000; role_manager=CassandraRoleManager; roles_cache_max_entries=1000; roles_update_interval_in_ms=-1; roles_validity_in_ms=2000; row_cache_class_name=org
.apache.cassandra.cache.OHCProvider; row_cache_keys_to_save=2147483647; row_cache_size_in_mb=0; row_cache_save_period=0; row_rpc_address=127.0.0.2; rpc_interface=null; rpc_interface_prefer_ipv6=false; rpc_keepalive=0
; rpc_listen_backlog=50; rpc_max_threads=2147483647; rpc_min_threads=16; rpc_port=9160; rpc_recv_buff_size_in_bytes=null; rpc_send_buff_size_in_bytes=null; rpc_server_type=sync; saved_caches_directory=null; s
aved_provider=org.apache.cassandra.locator.SimpleSeedProvider(seeds=127.0.0.1, 127.0.0.2); server_encryption_options=<REDACTED>; slow_query_log_timeout_in_ms=500; snapshot_before_compaction=false; snapshot_on_du
plicate_row_detection=false; ssl_storage_port=7001; stable_preemptive_open_interval_in_mb=50; start_native_transport=true; start_rpc=false; storage_port=7000; stream_throughput_outbound_megabits_per_sec=200; st
reaming_keep_alive_period_in_secs=300; streaming_socket_timeout_in_ms=86400000; thrift_framed_transport_size_in_mb=15; thrift_max_message_length_in_mb=16; thrift_prepared_statements_cache_size_mb=null; tombstone
_failure_threshold=100000; tombstone_warn_threshold=1000; tracetype_query_ttl=86400; tracetype_repair_ttl=604800; transparent_data_encryption_options=org.apache.cassandra.config.TransparentDataEncryptionOptions
{BWC=false, trickle_fsync=false, trickle_fsync_interval_in_kb=10240}; truncate_request_timeout_in_ms=60000; unlogged_batch_across_partitions_warn_threshold=10; user_defined_function_fail_timeout=1500; user_defined
_function_warn_timeout=500; user_function_timeout_policy=die; windows_timer_interval=1; write_request_timeout_in_ms=2000]
INFO [main] 2023-04-24 11:42:39,523 DatabaseDescriptor.java:381 - DiskAccessMode 'auto' determined to be mmap, indexAccessMode is mmap
INFO [main] 2023-04-24 11:42:39,529 DatabaseDescriptor.java:439 - Global memtable on-heap threshold is enabled at 4959B
INFO [main] 2023-04-24 11:42:39,530 DatabaseDescriptor.java:443 - Global memtable off-heap threshold is enabled at 4959B
INFO [main] 2023-04-24 11:42:39,795 RateBasedBackPressure.java:123 - Initialized back-pressure with high_ratio: 0.9, factor: 5, flow: FAST, window size: 2000.
INFO [main] 2023-04-24 11:42:39,786 DatabaseDescriptor.java:781 - Back-pressure is disabled with strategy org.apache.cassandra.net.RateBasedBackPressure(high_ratio=0.9, factor=5, flow=FAST).
INFO [main] 2023-04-24 11:42:39,979 JMXServerUtils.java:253 - Configured JMX server at: service:jmx:rmi:///127.0.0.1/jndi/rmi:///127.0.0.1:7299/jmxrmi
INFO [main] 2023-04-24 11:42:39,990 CassandraDaemon.java:690 - Hostname: LAPTOP-PL6GEB3E
Windows taskbar and system tray are visible at the bottom of the window.
```

Node 2 started:

```
INFO [main] 2023-04-24 11:47:11,232 QueryProcessor.java:174 - Preloaded 0 prepared statements
INFO [main] 2023-04-24 11:47:11,235 StorageService.java:699 - Cassandra version: 3.11.14
INFO [main] 2023-04-24 11:47:11,237 StorageService.java:700 - Thrift API version: 20.1.0
INFO [main] 2023-04-24 11:47:11,246 StorageService.java:781 - CQL supported versions: 3.4.4 (default: 3.4.4)
INFO [main] 2023-04-24 11:47:11,247 StorageService.java:703 - Native protocol supported versions: 3/v3, 4/v4, 5/v5-beta (default: 4/v4)
INFO [main] 2023-04-24 11:47:11,321 IndexSummaryManager.java:87 - Initializing index summary manager with a memory pool size of 99 MB and a resize interval of 60 minutes
INFO [main] 2023-04-24 11:47:11,642 MessagingService.java:750 - Starting Messaging Service on /127.0.0.2:7000
INFO [main] 2023-04-24 11:47:11,697 OutboundTcpConnection.java:108 - OutboundTcpConnection using coalescing strategy DISABLED
INFO [HANDSHAKE- /127.0.0.1] 2023-04-24 11:47:11,722 OutboundTcpConnection.java:561 - Handshaking version with /127.0.0.1
```

Node 3 started:

```
INFO [main] 2023-04-24 12:19:40,769 StorageService.java:1568 - JOINING: Finish joining ring
INFO [main] 2023-04-24 12:19:40,864 Gossiper.java:1869 - Waiting for gossip to settle...
INFO [main] 2023-04-24 12:19:48,866 Gossiper.java:1900 - No gossip backlog; proceeding
INFO [main] 2023-04-24 12:19:49,125 NativeTransportService.java:73 - Netty using Java NIO event loop
INFO [main] 2023-04-24 12:19:49,217 Server.java:158 - Using Netty Version: [netty-buffer-netty-buffer-4.0.44.Final.452812a, netty-codec-netty-codec-4.0.44.Final.452812a, netty-codec-haproxy-netty-codec-haproxy-4.0.44.Final.452812a, netty-codec-http-netty-codec-http-4.0.44.Final.452812a, netty-codec-socks-netty-codec-socks-4.0.44.Final.452812a, netty-common-netty-common-4.0.44.Final.452812a, netty-handler-netty-handler-4.0.44.Final.452812a, netty-tcnative-netty-tcnative-1.1.3.Fork26.142ecbb, netty-transport-netty-transport-4.0.44.Final.452812a, netty-transport-native-epoll-netty-transport-native-epoll-4.0.44.Final.452812a, netty-transport-rxtx-netty-transport-rxtx-4.0.44.Final.452812a, netty-transport-sctp-netty-transport-sctp-4.0.44.Final.452812a, netty-transport-udt-netty-transport-udt-4.0.44.Final.452812a]
INFO [main] 2023-04-24 12:19:49,218 Server.java:159 - Starting listening for CQL clients on /127.0.0.3:9042 (unencrypted)
INFO [main] 2023-04-24 12:19:49,415 CassandraDaemon.java:564 - Not starting RPC server as requested. Use JMX (StorageService->startRPCServer()) or nodetool (enablethrift) to start it
INFO [main] 2023-04-24 12:19:49,415 CassandraDaemon.java:650 - Startup complete
```

3 Node cluster formed:

```
C:\cassandra-3.11.14\bin>nodetool status
Datacenter: datacenter1
=====
Status=Up/Down
|/ State=Normal/Leaving/Joining/Moving
-- Address      Load          Tokens      Owns (effective)  Host ID                               Rack
UN 127.0.0.1     76.01 KiB     256         65.6%             47395b58-e7ad-42a4-9bd8-bff541e6f51c rack1
UN 127.0.0.2     70.95 KiB     256         69.4%             3adcad71-f600-44bc-8541-6cc0fcf1d1e9 rack1
UN 127.0.0.3     70.94 KiB     256         65.0%             476c5b61-685f-499d-9e31-4daf8e5f0d8c rack1
```

Creating Tables:

Node1

```
C:\Windows\System32\cmd.e  x  +  v

C:\cassandra-3.11.14\cassandra-3.11.14\bin>cqlsh

WARNING: console codepage must be set to cp65001 to support utf-8 encoding on Windows platforms.
If you experience encoding problems, change your console codepage with 'chcp 65001' before starting cqlsh.

Connected to 2020BTECS00080 at 127.0.0.1:9042.
[cqlsh 5.0.1 | Cassandra 3.11.14 | CQL spec 3.4.4 | Native protocol v4]
Use HELP for help.
WARNING: pyreadline dependency missing. Install to enable tab completion.
cqlsh> create keyspace AV with replication = {'class' : 'SimpleStrategy', 'replication_factor': 1};
cqlsh> use AV;
cqlsh:av> create table courses{ course_id int PRIMARY KEY, course_name text};
SyntaxException: line 1:20 no viable alternative at input '{' (create table [courses]{...)
cqlsh:av> create table courses( course_id int PRIMARY KEY, course_name text);
cqlsh:av> insert into courses(course_id, course_name) values (1, 'ADS');
cqlsh:av> select * from courses;

 course_id | course_name
-----+-----
          1 | ADS

(1 rows)
cqlsh:av> |
```


Accessible from node 2

```
C:\Windows\System32\cmd.e  X  +  v

C:\cassandra-3.11.14\cassandra-3.11.14\2\bin>cqlsh

WARNING: console codepage must be set to cp65001 to support utf-8 encoding on Windows platforms.
If you experience encoding problems, change your console codepage with 'chcp 65001' before starting cqlsh.

Connected to 2020BTECS00080 at 127.0.0.1:9042.
[cqlsh 5.0.1 | Cassandra 3.11.14 | CQL spec 3.4.4 | Native protocol v4]
Use HELP for help.
WARNING: pyreadline dependency missing.  Install to enable tab completion.
cqlsh> use AV;
cqlsh:av> select * from courses;
... select * from courses;
SyntaxException: line 2:0 no viable alternative at input 'select' (select * from [courses]select...)
cqlsh:av> select * from courses;

  course_id | course_name
-----+-----
          1 |          ADS
(1 rows)
cqlsh:av> insert into courses(course_id, course_name) values (2, 'CC');
cqlsh:av> select * from courses;

  course_id | course_name
-----+-----
          1 |          ADS
          2 |           CC
(2 rows)
cqlsh:av> |
```

Accessible from node 3

```
C:\Windows\System32\cmd.e  X  +  v

C:\cassandra-3.11.14\cassandra-3.11.14\3\bin>cqlsh

WARNING: console codepage must be set to cp65001 to support utf-8 encoding on Windows platforms.
If you experience encoding problems, change your console codepage with 'chcp 65001' before starting cqlsh.

Connected to 2020BTECS00080 at 127.0.0.1:9042.
[cqlsh 5.0.1 | Cassandra 3.11.14 | CQL spec 3.4.4 | Native protocol v4]
Use HELP for help.
WARNING: pyreadline dependency missing.  Install to enable tab completion.
cqlsh> use AV;
cqlsh:av> select * from courses;

  course_id | course_name
-----+-----
          1 |          ADS
          2 |           CC
(2 rows)
cqlsh:av> insert into courses(course_id, course_name) values (3, 'DL');
cqlsh:av> select * from courses;

  course_id | course_name
-----+-----
          1 |          ADS
          2 |           CC
          3 |           DL
(3 rows)
cqlsh:av> |
```

Conclusion: Clustering of 3 nodes in Cassandra successfully connected and implemented. Data is visible and accessible across all 3 nodes.

