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Effective Testing in DSE

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Why Taking Care?

- Automated testing for quality control of shipped product/service
- Number of tests and total testing times increase over time
- Shorter delivery cycles → continuous testing

- Run tests on each pre-merge check, but
- Keep feedback cycles short
- Ensure repeatable test execution anywhere

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DSE Build Facts

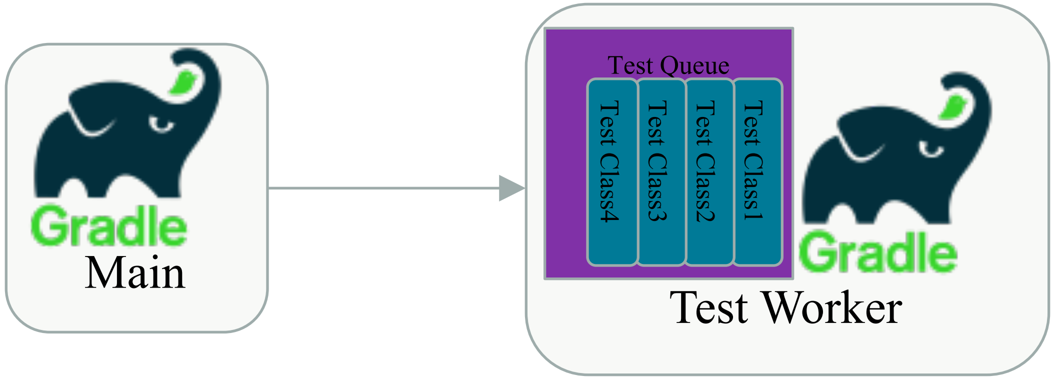
- Junit based test infrastructure
- December 2014 (DSE 4.6)
  - Ant based build system
  - ~5h for running all tests on Jenkins, with a rather complicated job layout
- July 2016 (DSE 4.7+)
  - Gradle based build system
  - 40-60mins for running all tests on Jenkins
  - 16 hours of total testing time
  - The number of tests doubled!
  - Repeatable test execution across all machines
  - Simple setup

Why Moving to Gradle?

- Built-in support for parallel test execution
- Readable - build scripts based on Groovy (easy learning for Java devs)
- Repeatable builds/environment setup across machines
- Powerful dependency management
- Sane conventions, but configurable when needed
- Easy project modularization
- Excellent Eclipse/IntelliJ support
- Easy extendable through plugins or additional Java/Groovy code living in the script or project
- All Ant tasks still available

Running Tests

- All: `gradlew test`
- Single: `gradlew test -Dtest.single=FooTest`
- By default sequential execution
  - Low resources usage on modern multicore hardware
  - Long test round duration



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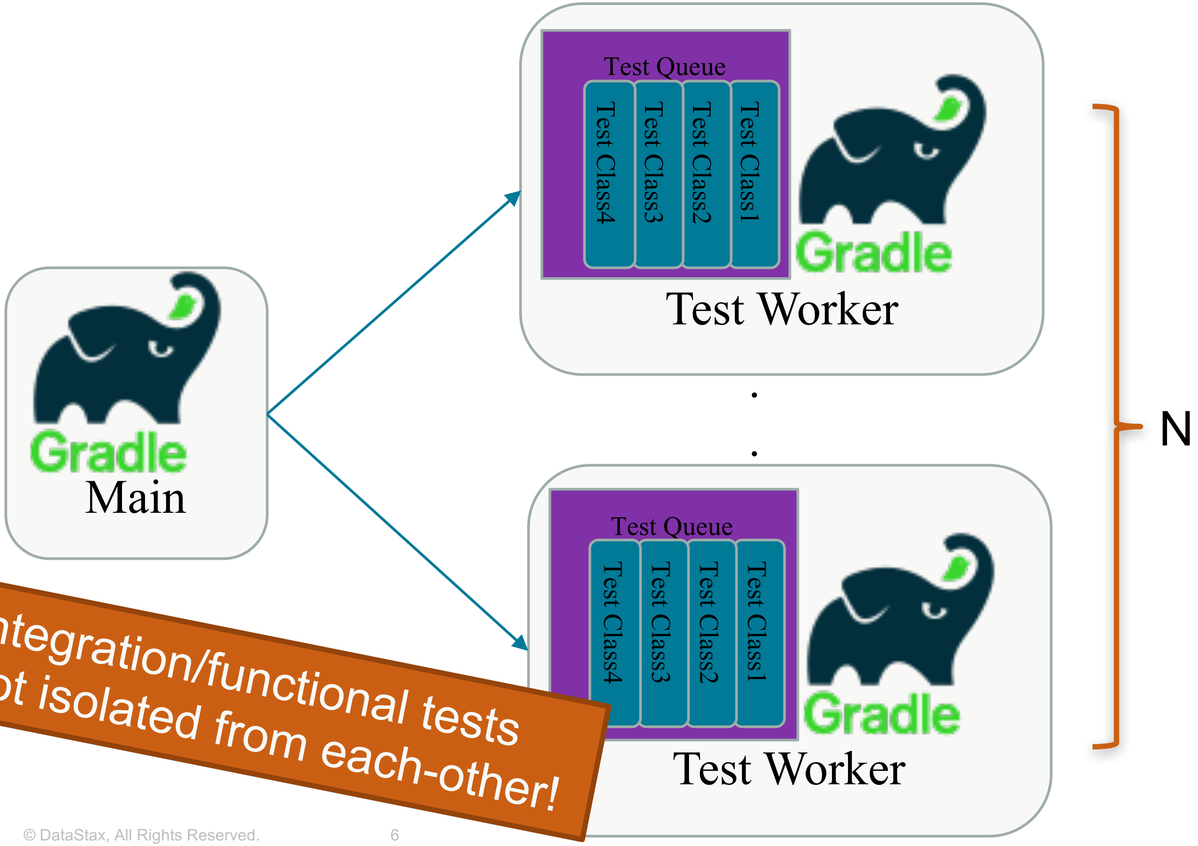
Parallel Test Execution



build.gradle

```
test {
  maxParallelForks = N
}
```

Integration/functional tests not isolated from each-other!

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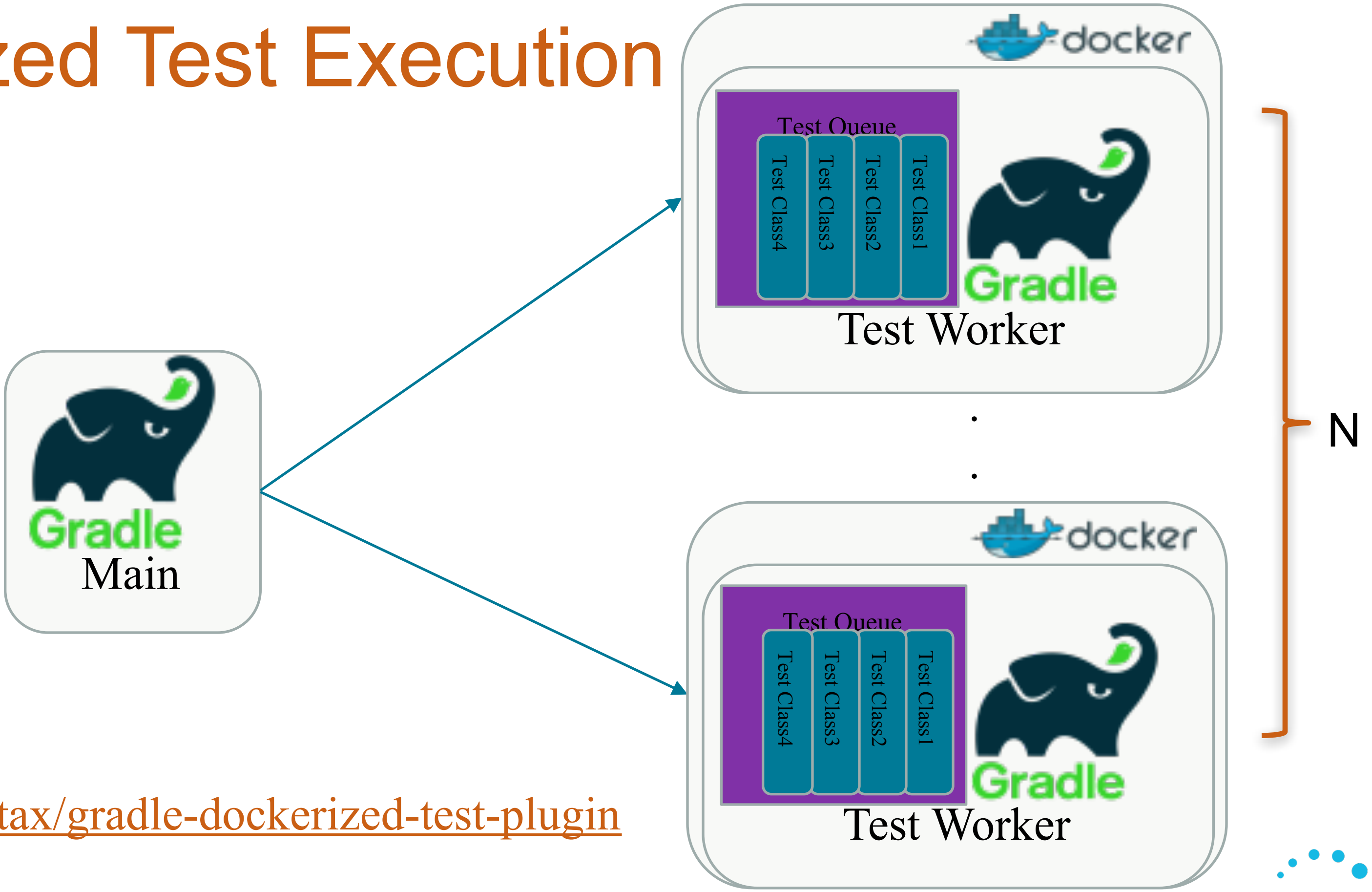
Dockerized Test Execution



github.com/datastax/gradle-dockerized-test-plugin

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Dockerized Test Execution (2)

- Install Docker locally (native or boot2docker)
- No changes on production or test code required
- Test environment
  - Consistent across all machines (dev + CI)
    → no more “it works on my machine”
  - Managed as code (Dockerfiles) within project
  - Easy machine bootstraping
  - Fully isolated
- Easy testing against
  several and/or appropriate environment

build.gradle

```
test {
  maxParallelForks = N
  docker {
    image = ’test-image’
  }
}
```

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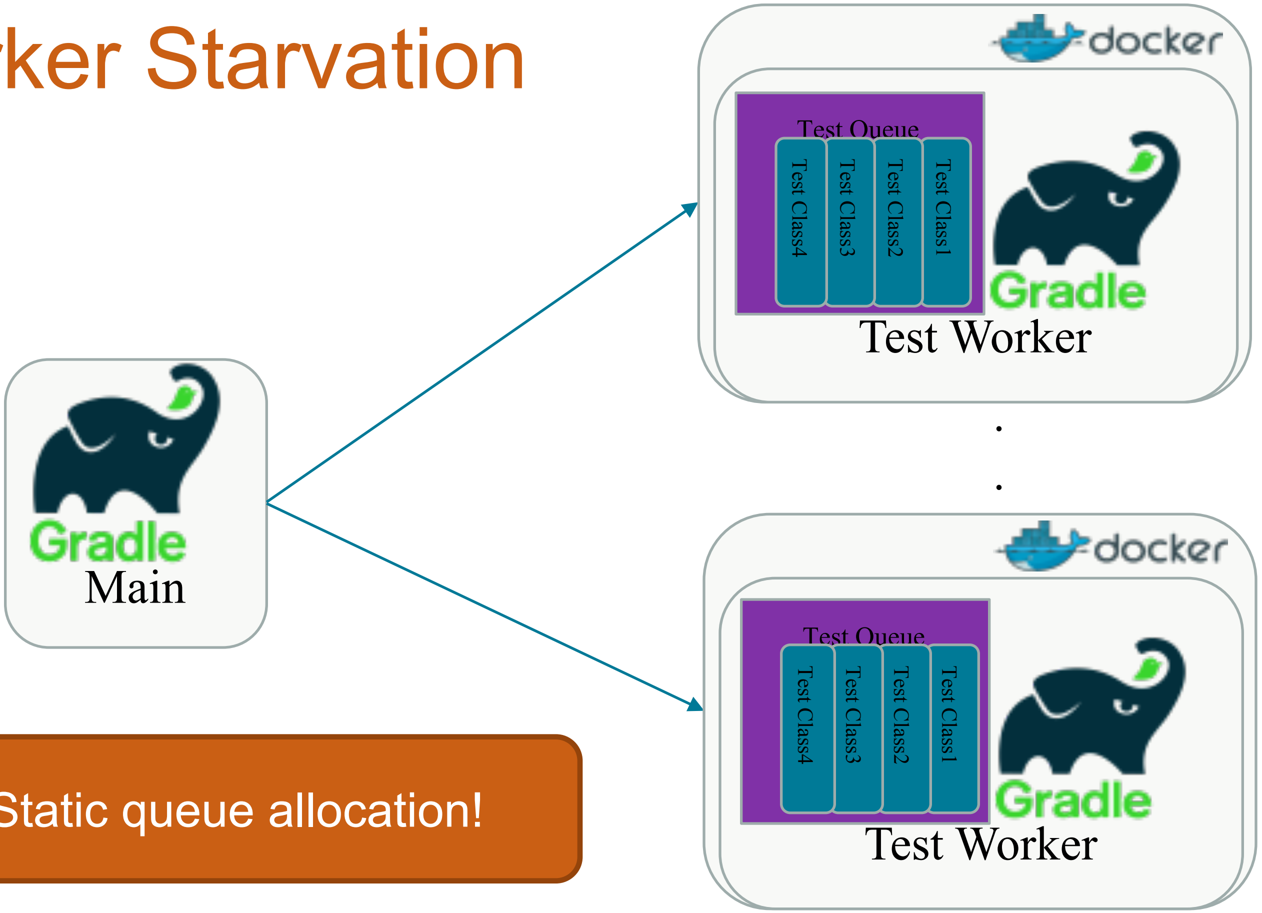
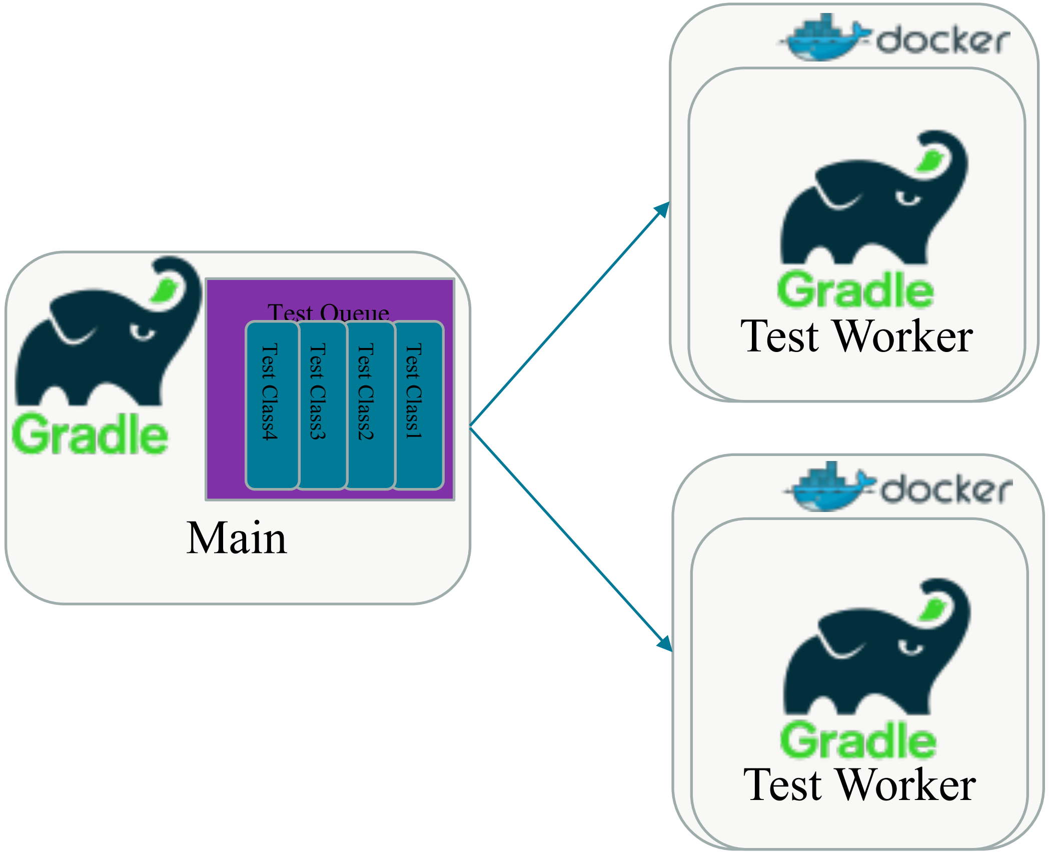
Worker Starvation



Static queue allocation!

Improved Queue Management



The duration of test round depends on the order of the test classes in the queue!

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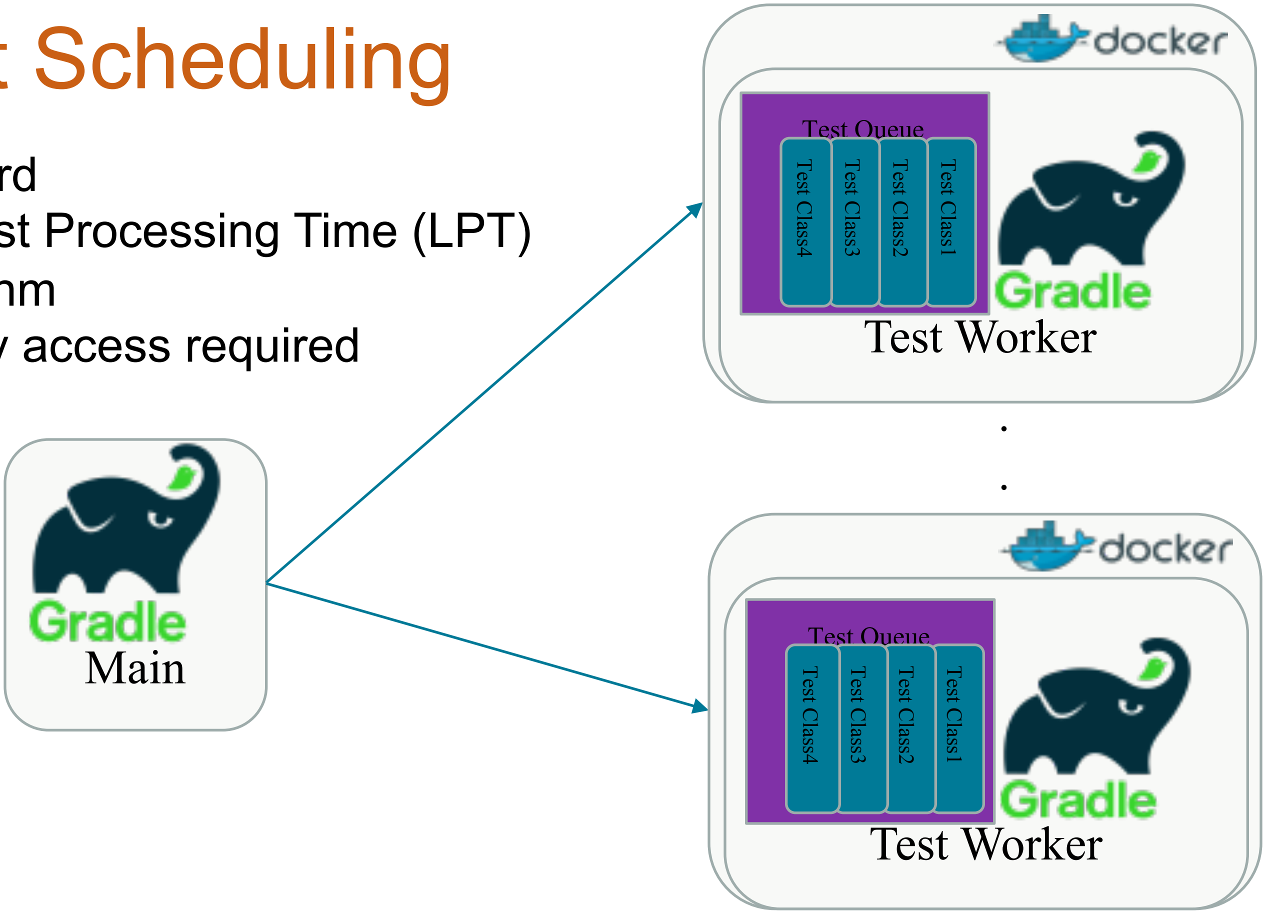
Test Scheduling

- NP-hard
- Longest Processing Time (LPT) algorithm
- History access required



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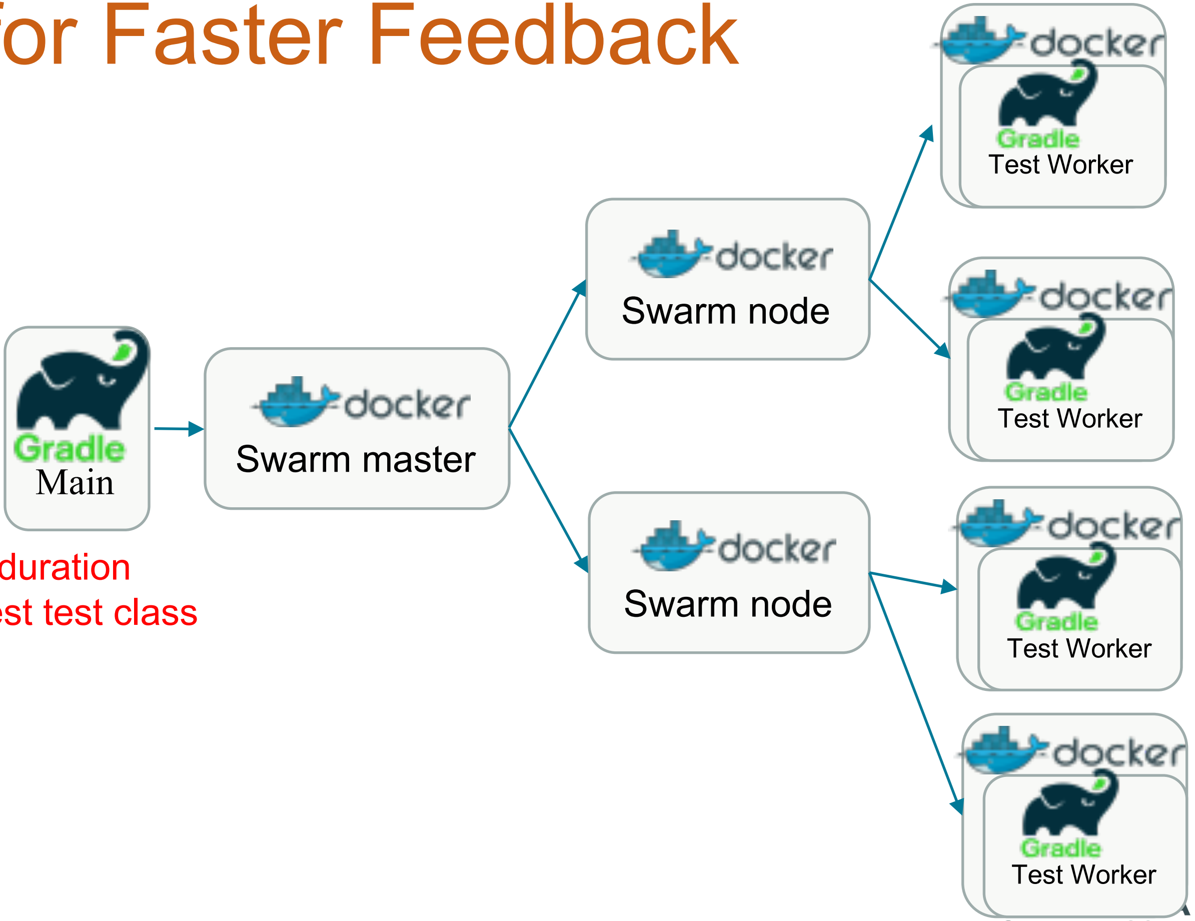
More Workers for Faster Feedback

- Powerful multi-core machine
- Docker Swarm
  - Virtual Docker engine
  - Test workers run on a Swam node
  - Cluster can shrink or grow

- Lower bound for the test round duration is equal to the duration of slowest test class



Split Slow Test Classes for More Throughput

- Manual
  - Group by common fixture
  - Extreme: one test per class
- Bytecode manipulations (auto split annotated class)
- Grouping tests classes into JUnit suites forces their sequential execution!

```
class FooTest {
@Test
void bar1() {
}

@Test
void bar2() {
}

}
```

```
class Foo1Test {
@Test
void bar1() {
}
}

class Foo2Test {
@Test
void bar2() {
}

}
```

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No Embedded DSE Nodes

- Running cluster within single test worker JVM possible only by using separate classpath loaders
  - Still requires a good amount of hacking to make it work decently
  - Node shutdowns might still be problematic
    - Thread can hang around
    - Some objects cannot be garbage collected → memory leaks
- Standalone nodes enable reusage across test classes

Remote Code Execution

- MobilityRPC library (http://github.com/npgall/mobility-rpc)
- Remote JUnit Testrunner (http://github.com/datastax/remote-junit-runner)
  - Useful for integration tests requiring application context, but application cannot be easily embedded into test JVM
  - Support any existing JUnit runner on the remote side (Parametrized, Spock, Suites)

```
@RunWith(Remote.class)
public class RemoteTest {

  @Test
  public void foo() {
    // test
  }
}
```

Injecting Faults

- JBoss Byteman (http://byteman.jboss.org)
- Inject at runtime
  - Exceptions
  - Delays
  - Arbitrary side-effects
- Enables/simplifies testing of edge/uncommon cases

Logging

- Logback (http://logback.qos.ch/) based infrastructure
- Log file per a test case
  - Send all log messages to the single logback server asynchronously (reactor-logback adapter) keeping DSE nodes responsive
  - Route log statements to the proper file using SiftingAdapter and appropriate discriminator
  - Use JUnit rules to mark the beginning and the end of a test and propagate this information to the logback discriminator
  - Write thread dumps in case of a failure
- Scan log files for known issues and fail tests if they occur (e.g. Netty memory leaks)
- Turn DEBUG messages on to help later digging in a case of failure

Log Event Sender

```
<appender name="SOCKET" class="com.datastax.bdp.logback.SocketAppender">
    <remoteHost>${logbackServer}</remoteHost>
    <port>12345</port>
    <reconnectionDelay>1 seconds</reconnectionDelay>
    <nodeId>${nodeid}</nodeId>
    <eventDelayLimit>120 seconds</eventDelayLimit>
</appender>

<appender name="ASYNC" class="reactor.logback.AsyncAppender">
    <includeCallerData>true</includeCallerData>
    <appender-ref ref="SOCKET"/>
</appender>

<root level="DEBUG">
    <appender-ref ref="ASYNC"/>
</root>
```

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Log Event Router

```
<appender name="SIFT" class="ch.qos.logback.classic.sift.SiftingAppender">
    <discriminator class="com.datastax.bdp.test.ng.LogFileDiscriminator">
        <key>TEST_LOG_FILE</key>
        <defaultValue>system.log</defaultValue>
    </discriminator>
    <sift>
        <appender name="FILE-${TEST_LOG_FILE}" class="ch.qos.logback.core.FileAppender">
            <filter class="com.datastax.bdp.test.ng.ForbiddenLogEventsDetector">
              <logFile>${TEST_LOG_FILE}</logFile>
              <detector class="com.datastax.bdp.test.ng.NettyLeakDetector"/>
            </filter>
            <encoder>
                <pattern>%X{nodeid} %5p [%t] %d{ISO8601} %F \(line %line\) %m%n</pattern>
                <immediateFlush>false</immediateFlush>
            </encoder>
            <file>${LOG_DIR}/${TEST_LOG_FILE}</file>
            <append>true</append>
        </appender>
    </sift>
</appender>
```

Test Start/End Detection

```
@Rule
public TestRule watcher = new TestWatcher() {

    private String logFile;

    @Override
    protected void starting(Description description) {
        logFile = description.getClassName()+"/"+description.getMethodName()+".log";
        logToFile(logFile);
    }

    protected void failed(Throwable e, Description description) {
        threadDumpLogger.error("Test {}.{} failed, thread dump:\n{}\n", description.getClassName(),
                description.getMethodName(), getThreadDumps());
        logToFile(description.getClassName()+"/after.log");
    }

    protected void finished(Description description) {
        logToFile(description.getClassName()+"/after.log");
        ForbiddenLogEventsDetector.checkForIssues(logFile);
    }
};
```

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Resources

- Gradle (gradle.org)
- Docker (docker.com)
- Gradle Dockerized Test Plugin (github.com/datastax/gradle-dockerized-test-plugin)
- MobilityRPC (http://github.com/npgall/mobility-rpc)
- Remote JUnit Testrunner (http://github.com/datastax/remote-junit-runner)
- JBoss Byteman (http://byteman.jboss.org)
- Logback (http://logback.qos.ch/)
- Project Reactor Addons (github.com/reactor/reactor-addons), Logback adapter

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Thank you!

Questions?