Deploying Apache ActiveMQ for Reliability and Scalability

Rob Davies
CTO
FuseSource

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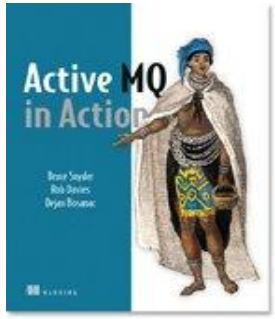
Presenter: Rob Davies

- CTO at FuseSource - “the experts in open source integration and messaging” http://fusesource.com
- Apache ActiveMQ, ServiceMix and Camel PMC member
- Co-creator of ActiveMQ, ServiceMix and Camel
- Co-author of ActiveMQ in Action:
  - Chapter 5:ActiveMQ Message Store
  - Chapter 10: Deploying ActiveMQ in the Enterprise
  - Chapter 11: ActiveMQ Broker Features In Action
  - Chapter 12: Advanced Client Options
  - Chapter 13: Tuning ActiveMQ for Performance



- Blog: http://rajdavies.blogspot.com/
- Twitter: http://twitter.com/rajdavies

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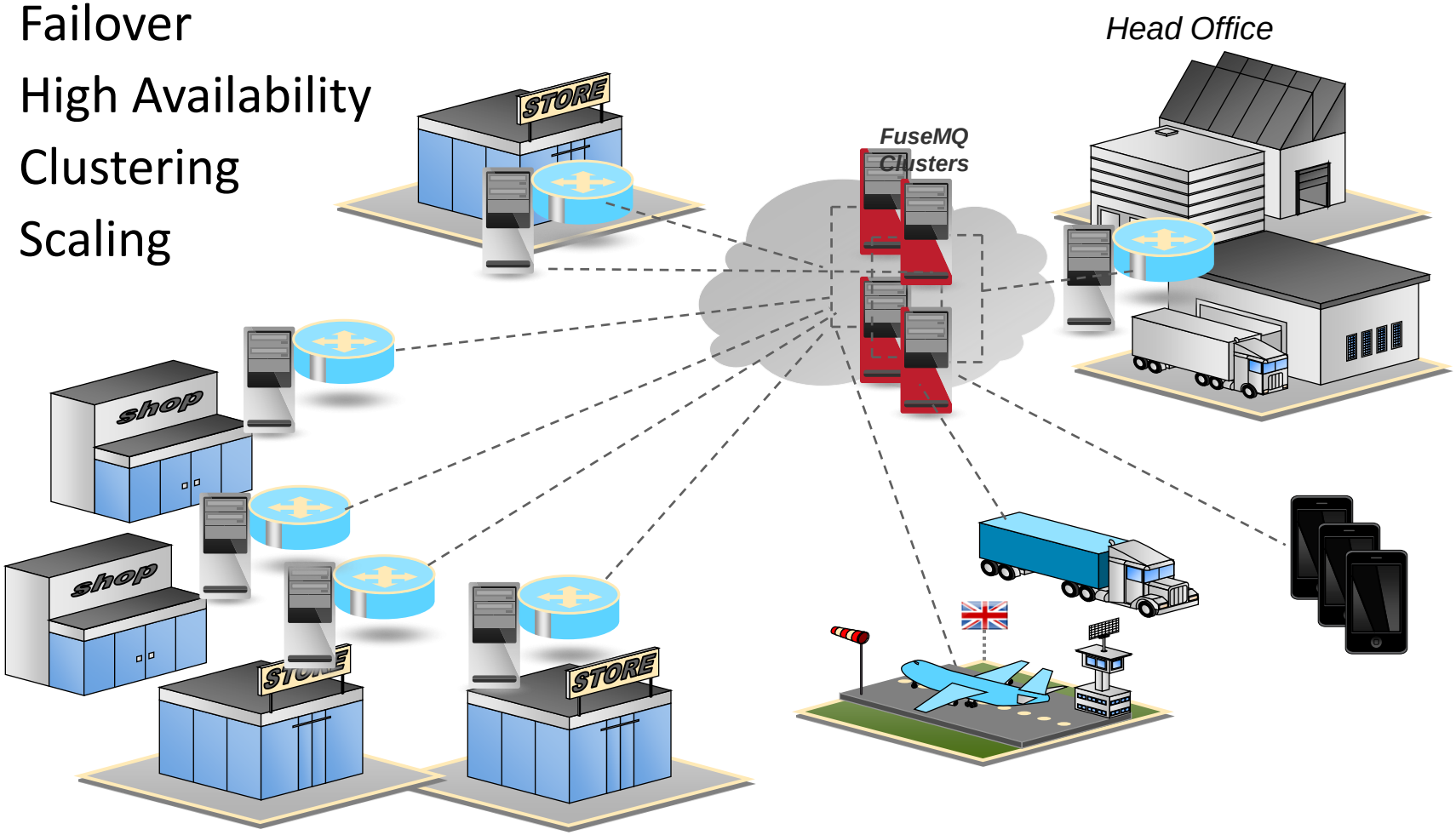
Apache ActiveMQ – Enterprise Features

- Failover
- High Availability
- Clustering
- Scaling



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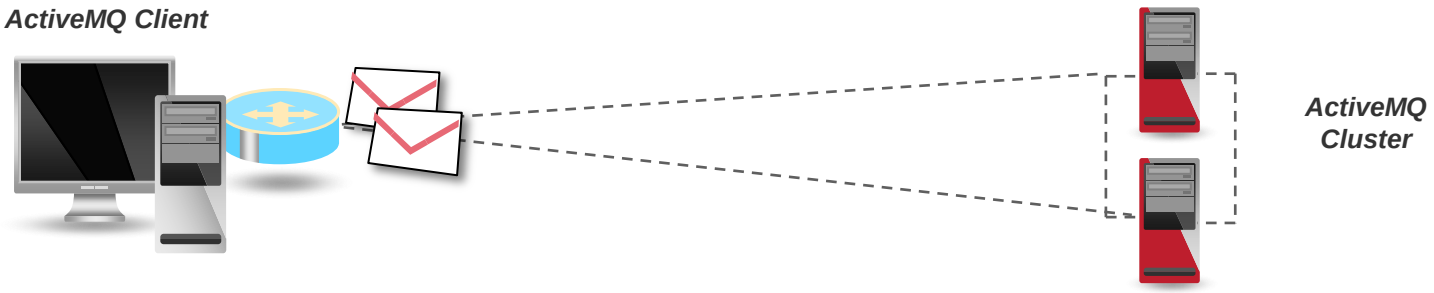
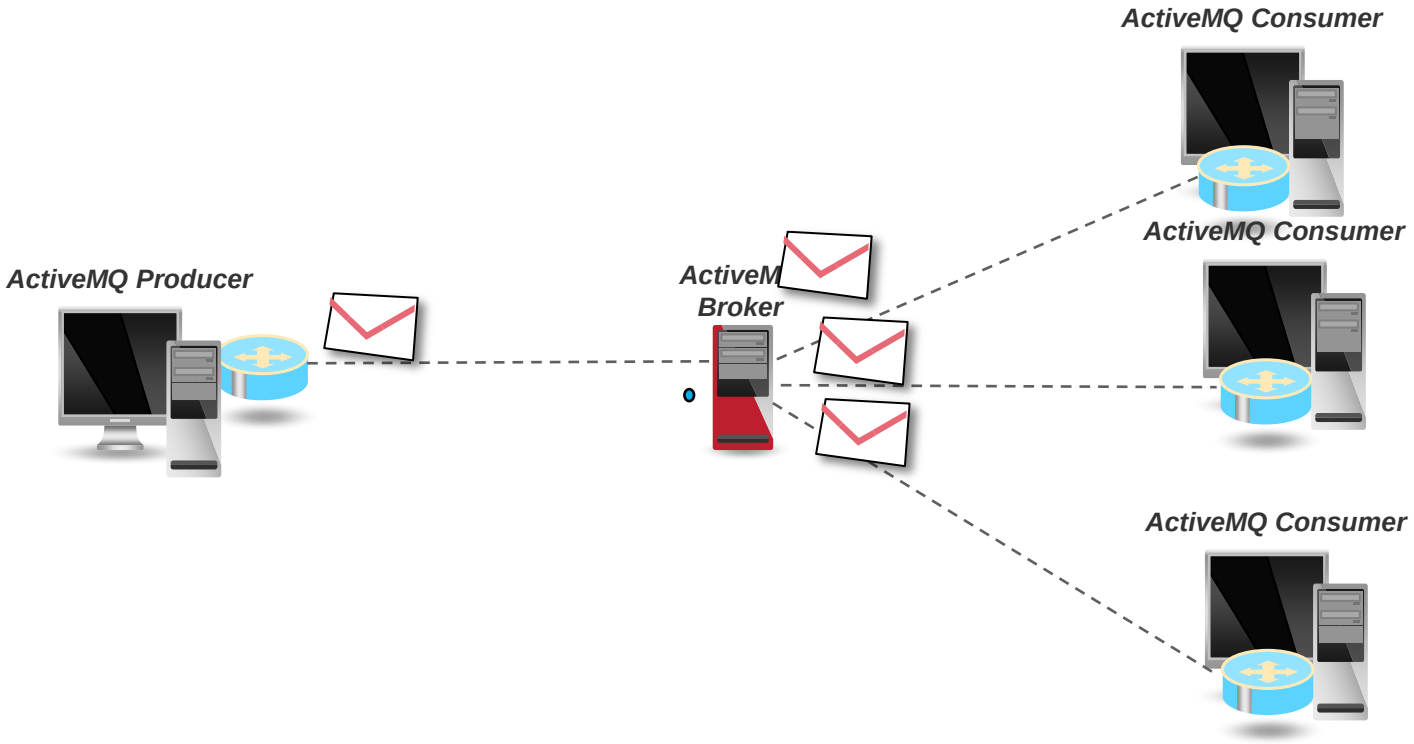
Apache ActiveMQ – Enterprise Features

Failover

- Java and C++ clients support seamless failover



Apache ActiveMQ – Synchronous sends



Apache ActiveMQ – Synchronous sends

Synchronous send: JMS Client

Set alwaysSyncSend on the ActiveMQConnectionFactory

You can set:
sendTimeout on the ActiveMQMessageProducer

BTW -

In ActiveMQ 5.6 – you can get a callback – e.g.:

```
producer.send(session.createTextMessage("Hello"), new AsyncCallback() {
      public void onSuccess() {}

      public void onException(JMSException exception) {
            exception.printStackTrace();
      }
});
```

Apache ActiveMQ – Enterprise Features

JMS async send can be made reliable

- failover:// transport (default) detects network outages
- failover:// can replay messages by enabling trackMessages :

failover:(tcp://hostA:61617,tcp://hostB:61617)?trackMessages=true

ActiveMQ High Availability

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Apache ActiveMQ – High Availability

Three types of Master/Slave.

- Fully replicated Master/Slave
- JDBC Master/Slave
- Shared File System Master/Slave

Apache ActiveMQ – High Availability

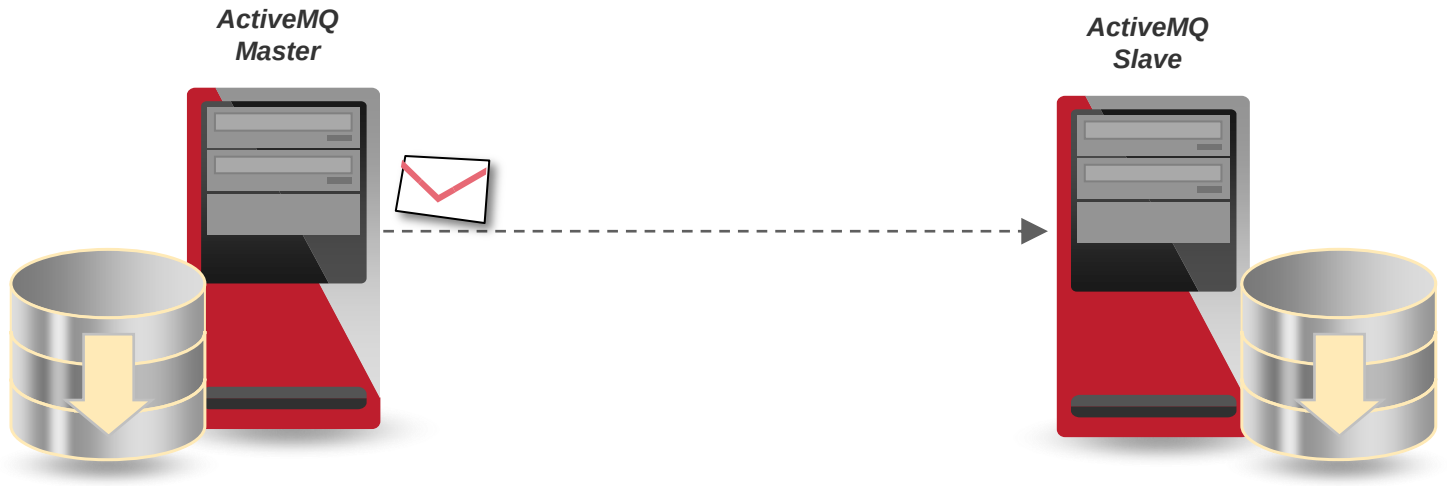
Fully Replicated Master/Slave

- Shared nothing
- Fully replicated
  - All messages
  - All acknowledgements
  - All transactions
- Slave does not start any transports or network connections

Apache ActiveMQ – High Availability

Fully Replicated Master/Slave

```
<broker masterConnectorURI="tcp://masterhost:62001" shutdownOnMasterFailure="false">
```




```
failover://(tcp://masterhost:61616,tcp://slavehost:61616)?randomize=false
```

Fully Replicated Master/Slave - Limitations

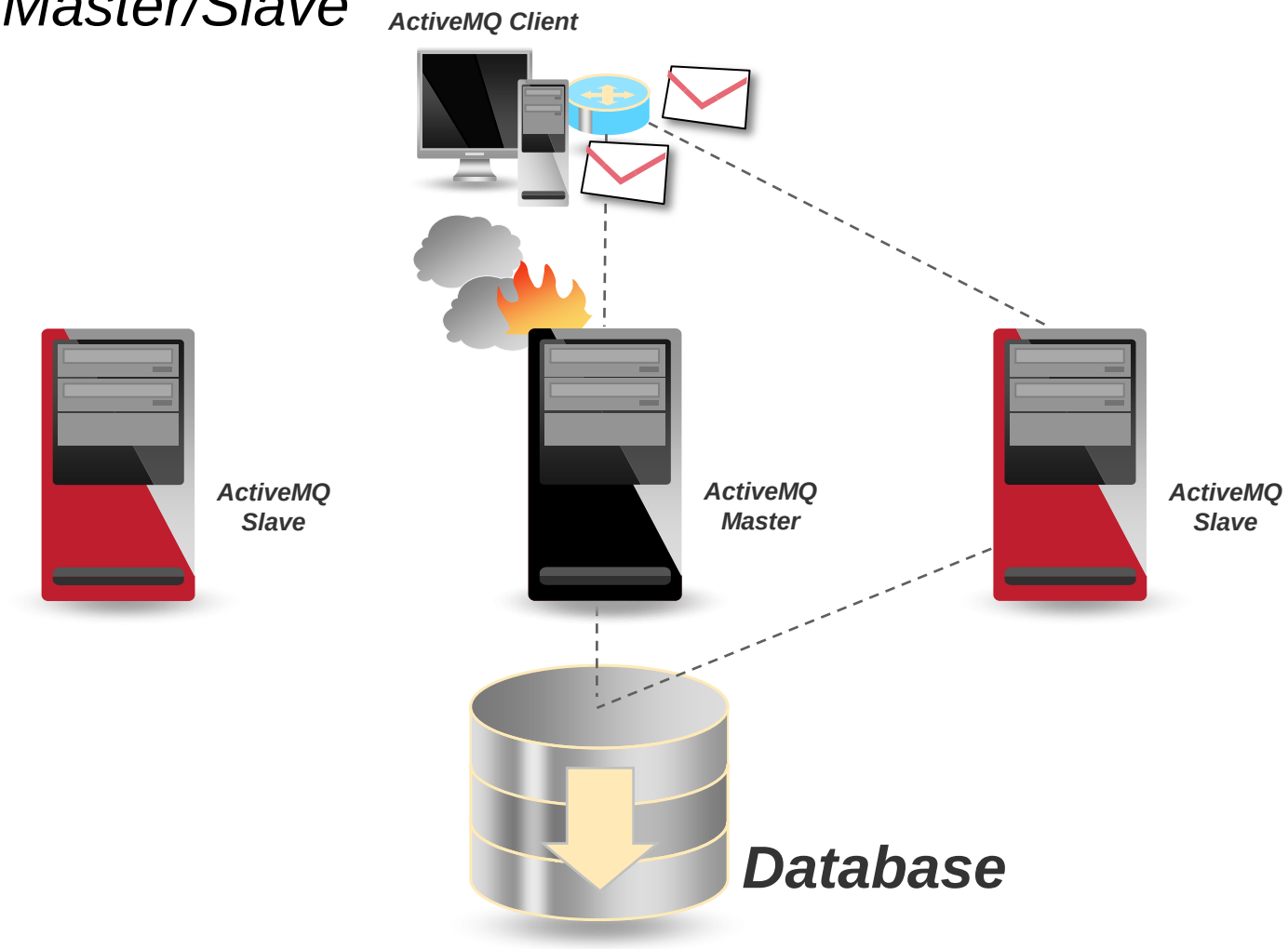
- Only one slave can be connected to a Master
- No automatic failback
- No automatic synchronization after master re-start

Fully Replicated Master/Slave - Recovery

- *Shutdown the slave broker (clients don't need to be)*
- *Copy the message database to the master*
- *Re-start the master and the slave*

Apache ActiveMQ – High Availability

JDBC Master/Slave



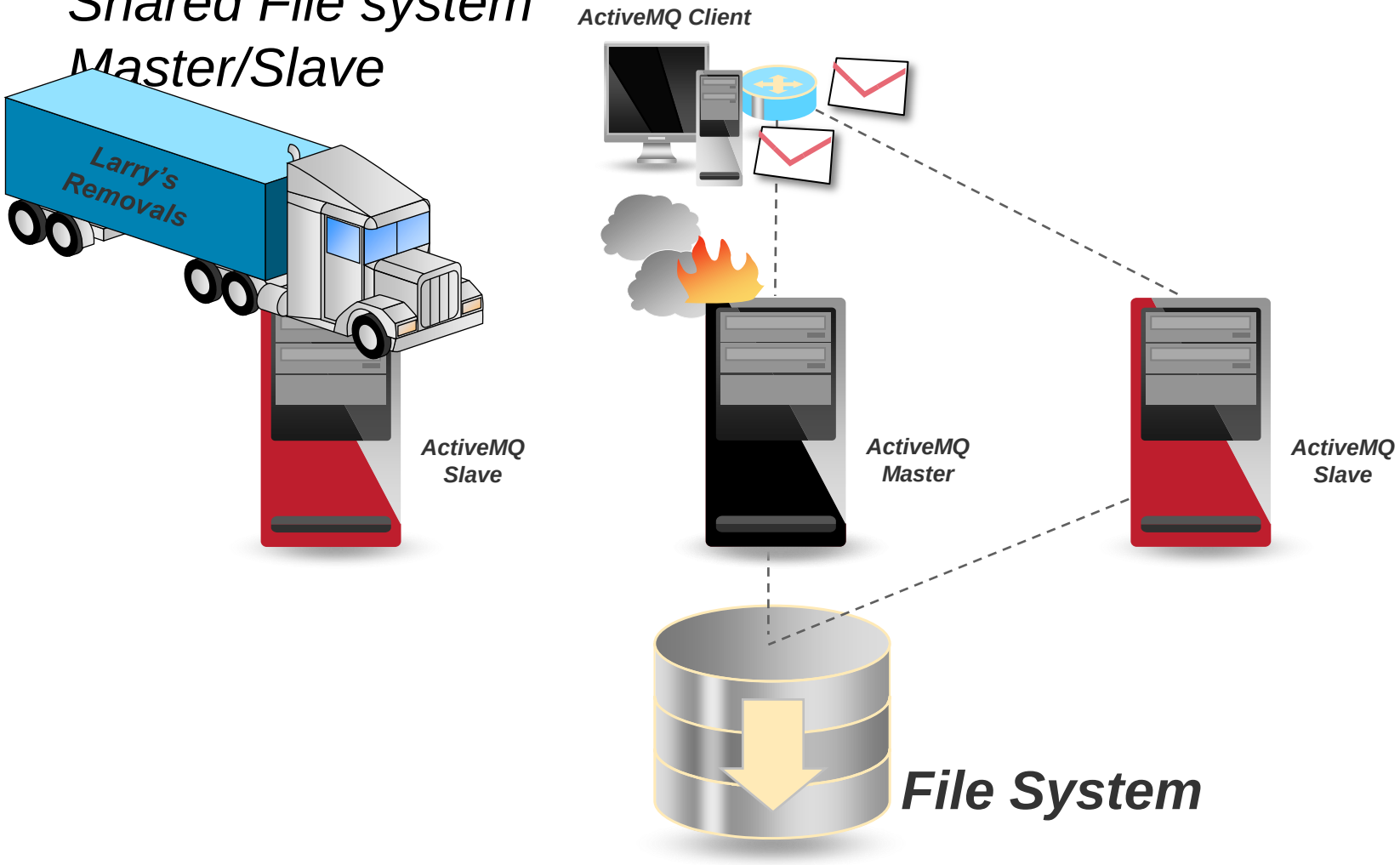
Apache ActiveMQ – High Availability

JDBC Master/Slave

- Extreme reliability – but not as fast
- Recommended if already using an enterprise database
- No restriction on number of slaves
- Simple configuration
- Configurable lockKeepAlivePeriod

Apache ActiveMQ – High Availability

Shared File system Master/Slave



Apache ActiveMQ – High Availability

Shared File Master/Slave

- Recommended if you have a SAN, or DRDB or NFS
- No restriction on number of slaves
- Simple configuration
- N.B. – ensure file locking works – and times out – NFSv4 good!
- On KahaDB the lock is ***databaseLockedWaitDelay***

failover://(tcp://host1:61616,tcp://host2:61616)

ActiveMQ Broker Topologies

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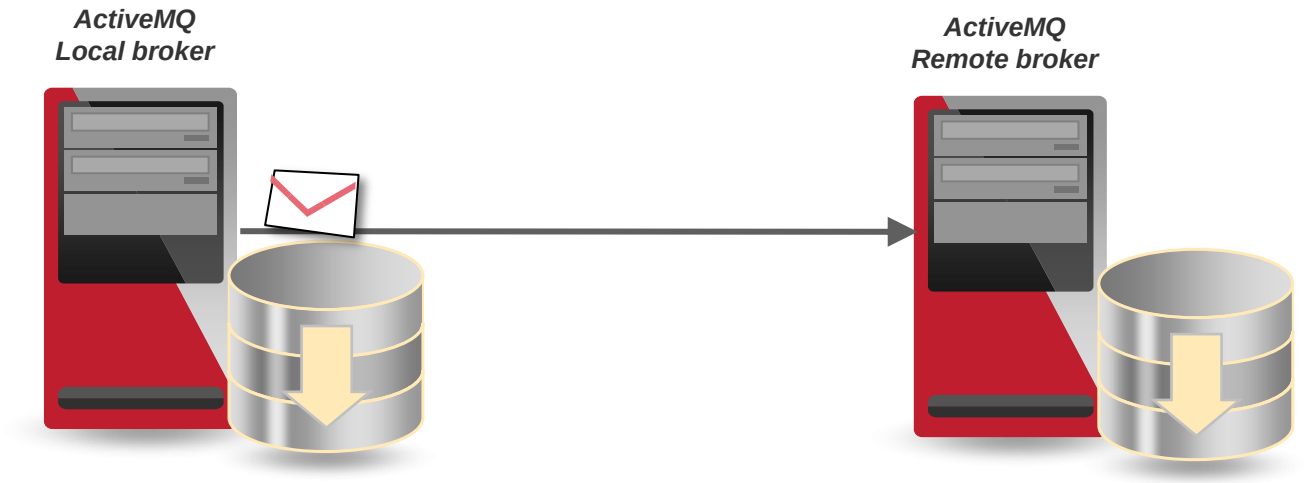
Apache ActiveMQ – Broker Topologies

Networks

- Link ActiveMQ Brokers together
- Use Store and Forward
- Are uni-directional by default
- All Destinations are global

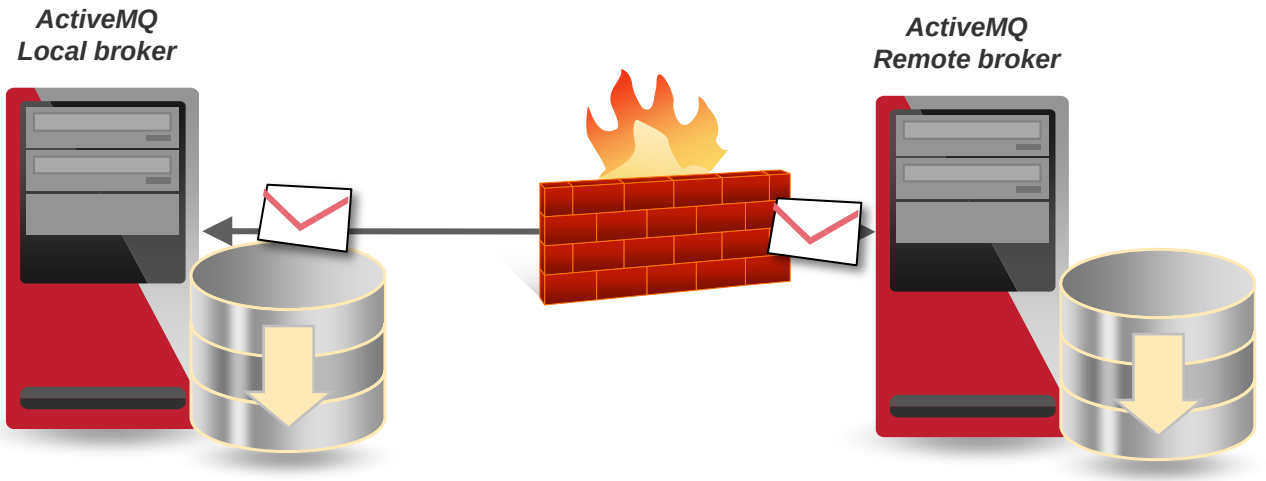
Apache ActiveMQ – Broker Topologies

Store and Forward



Apache ActiveMQ – Broker Topologies

Bi-directional network

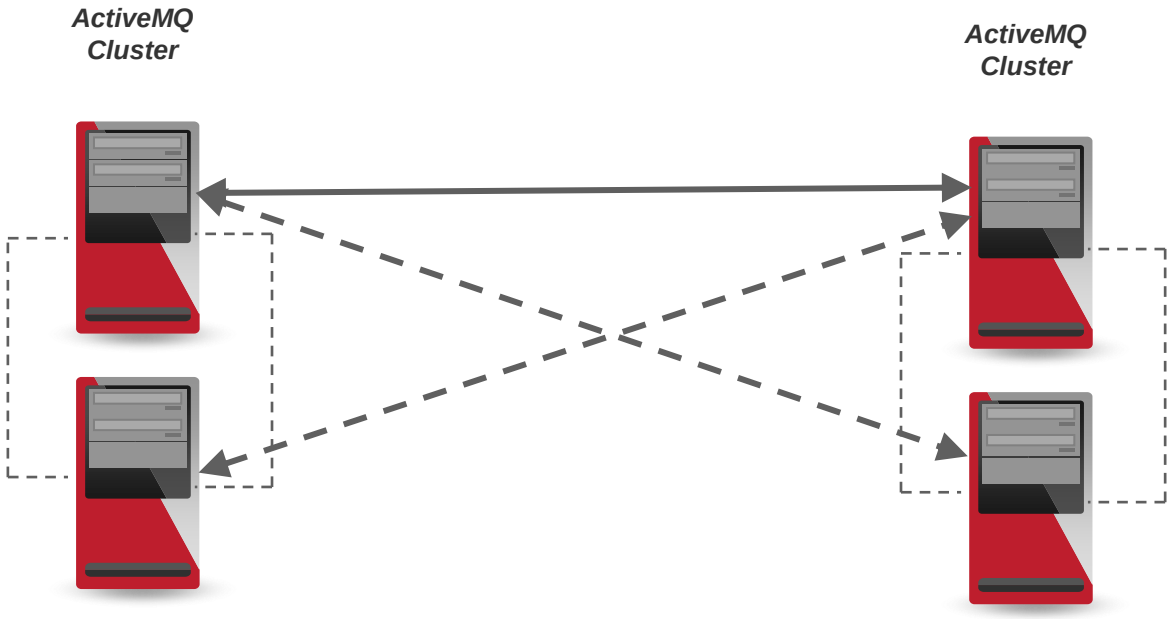


Bi-directional network - Configuration

```
<networkConnectors>
    <networkConnector uri="static://(tcp://backoffice:61617)"
      name="bridge"
      duplex="true"
      conduitSubscriptions="true"
      decreaseNetworkConsumerPriority="false">
    </networkConnector>
  </networkConnectors>
```

Apache ActiveMQ – Broker Topologies

Combining HA and Networks



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Networks – Configuration for master/slave (from 5.6)

```
<networkConnectors>
   <networkConnector uri="masterslave:(tcp://master,tcp://slave)"/>
</networkConnectors>
```

Which is the same as:

```
<networkConnectors>
   <networkConnector
uri="static:failover:(tcp://master,tcp://slave)?randomize=false&maxReconnectAttempts=0"/>
</networkConnectors>
```

Apache ActiveMQ – Broker Topologies

Networks – Configuration – Filters: dynamicallyIncludedDestinations

```
<networkConnectors>
    <networkConnector uri="static:(tcp://remote:61617) "/>
      <dynamicallyIncludedDestinations>
          <queue physicalName=”free.food.>"/>
          <queue physicalName=”free.beer.>"/>
          <topic physicalName=”cricket.scores.>"/>
       </excludedDestinations>
</networkConnectors>
```

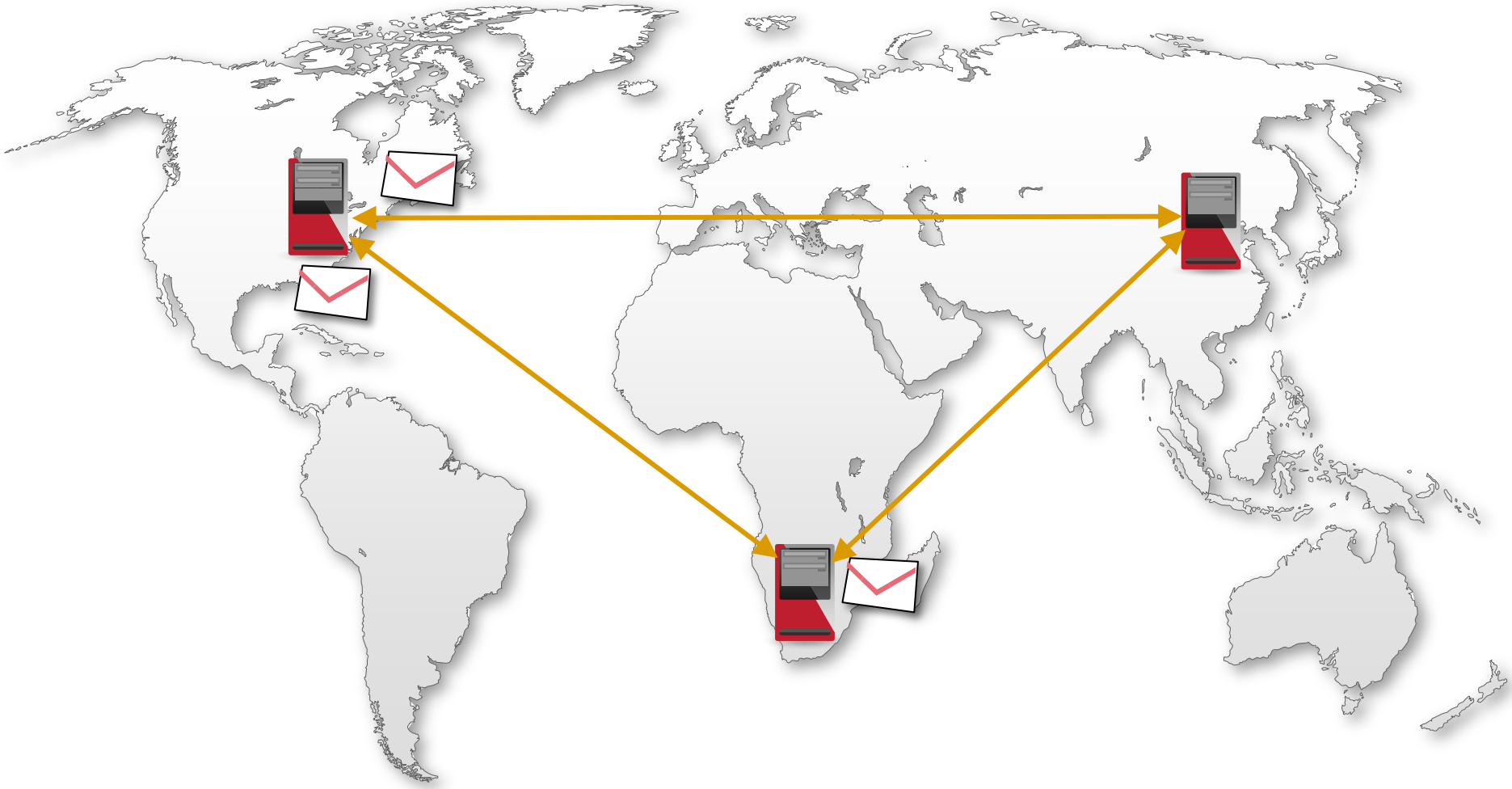
Apache ActiveMQ – Broker Topologies

Networks – Configuration – Filters: staticallyIncludedDestinations

```
<networkConnectors>
    <networkConnector uri="static:(tcp://remote:61617)?useExponentialBackOff=false"/>
      <staticallyIncludedDestinations>
          <queue physicalName="management.queue-1"/>
          <queue physicalName="management.queue-2"/>
          <queue physicalName="global.>"/>
          <topic physicalName="global.>"/>
       </staticallyIncludedDestinations>
 </networkConnectors>
```

Apache ActiveMQ – Broker Topologies

Networks – Configuration – networkTTL=2



ActiveMQ – geographically dispersed data centers: redundant links – Topic support

Enable duplicate subscriptions over the network:

```
<networkConnectors> <networkConnector uri="static:(tcp://brokerB:61617)" name="A-B"
networkTTL="2" suppressDuplicateTopicSubscriptions="false"> </networkConnector>
<networkConnector uri="static:(tcp://brokerC:61618)" name="A-C" networkTTL="2"
suppressDuplicateTopicSubscriptions="false">
</networkConnector> </networkConnectors>
```

Ensure every Topic message is only sent through one network connection - the one with the highest priority:

```
<destinationPolicy>
  <policyMap>
    <policyEntries>
      <policyEntry topic=">" enableAudit="true">
        <dispatchPolicy>
                <priorityNetworkDispatchPolicy/>
          </dispatchPolicy>
      </policyEntry>
    </policyEntries>
  </policyMap>
</destinationPolicy
```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ActiveMQ Scaling

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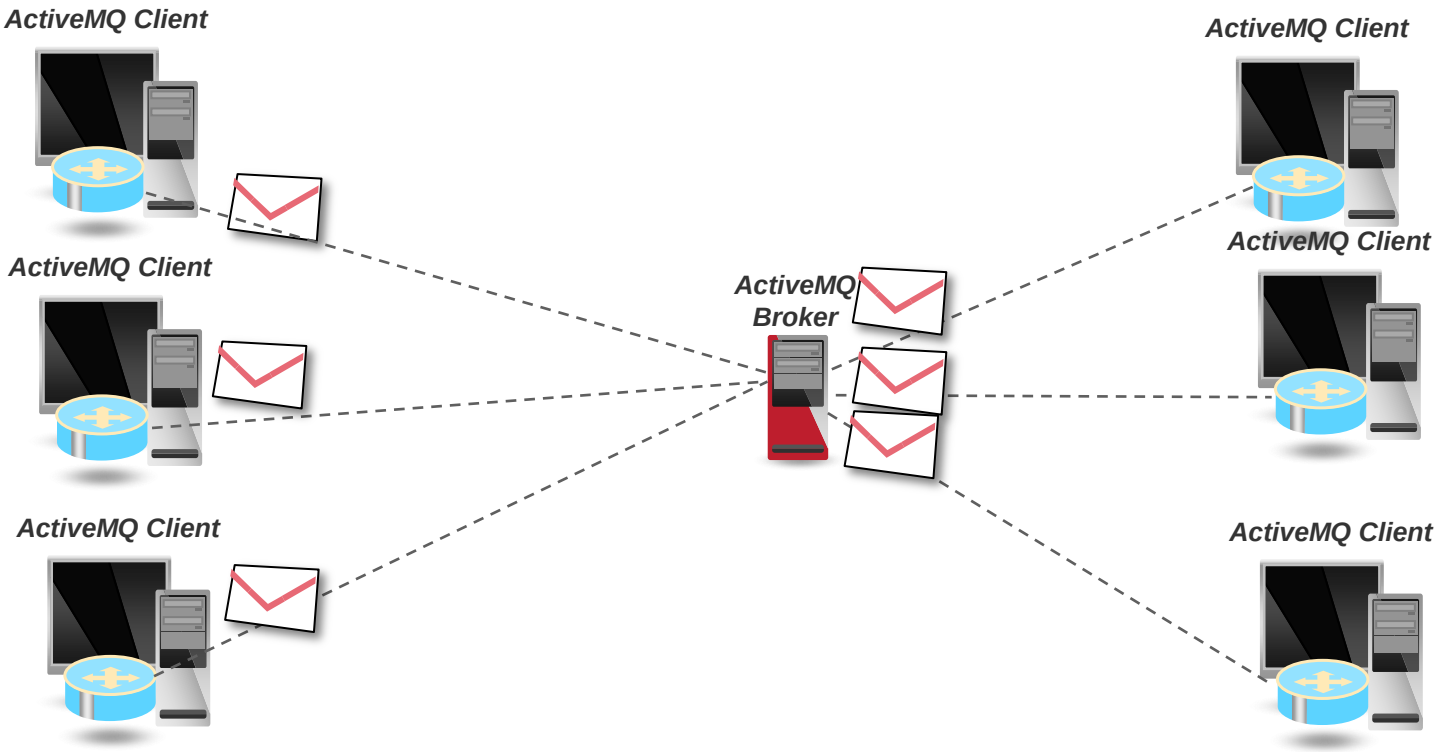
ActiveMQ – Vertical Scaling



Apache ActiveMQ – Vertical Scaling

Reduce the number of Broker Threads

```
ACTIVEMQ_OPTS=

"-Xmx1024M -Dorg.apache.activemq.UseDedicatedTaskRunner=false"
```

Reduce thread usage by Destinations

```
<destinationPolicy>
    <policyMap>
      <policyEntries>
        <policyEntry queue=">" optimizeDispatch=”true” />
      </policyEntries>
    </policyMap>
  </destinationPolicy>
```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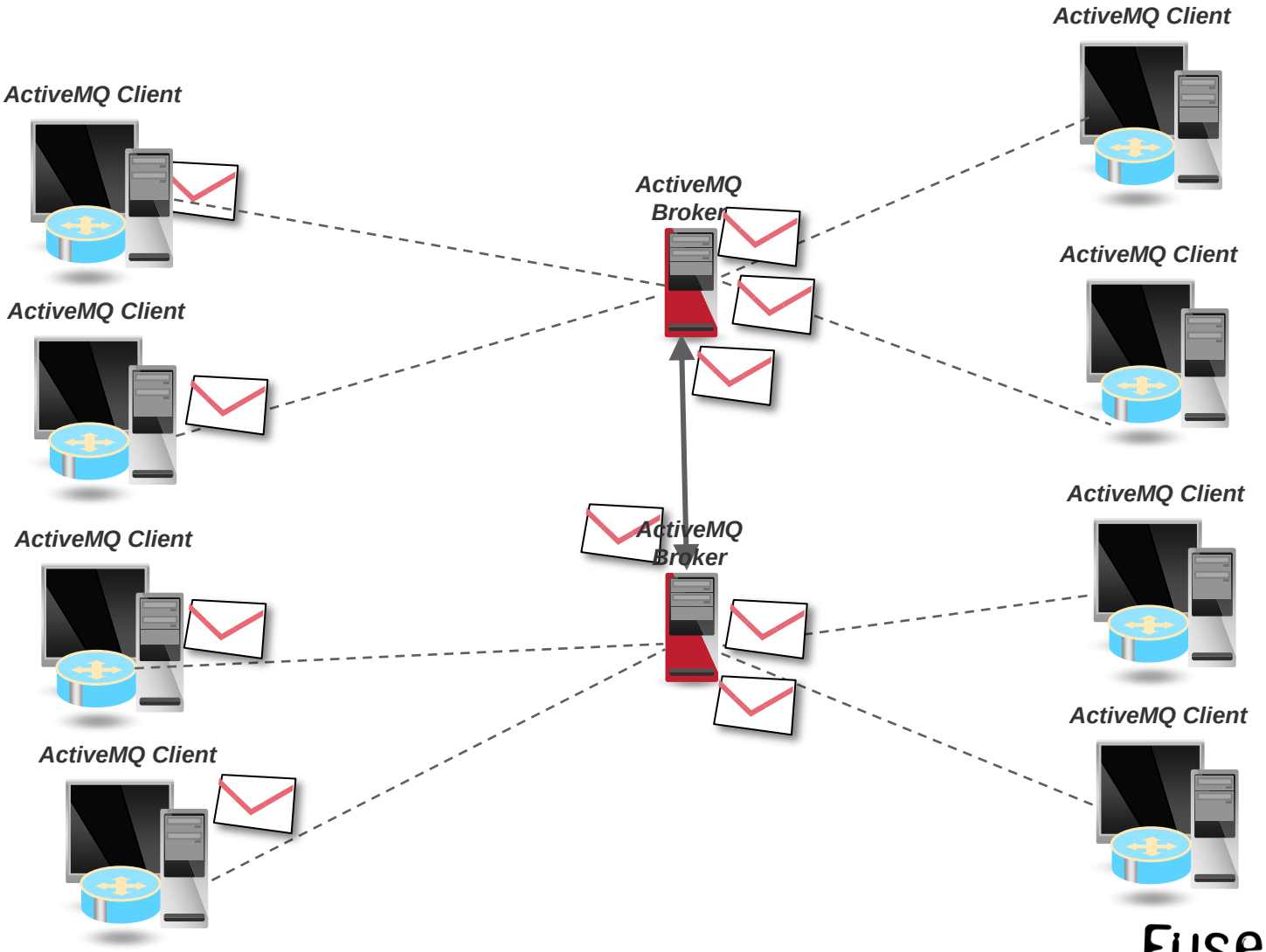
Apache ActiveMQ - Scaling

Vertical Scaling: Other things to improve Vertical Scaling

- Use the nio transport on the ActiveMQ broker
- Increase the amount of memory available to the broker
- Reduce the default JVM stack size of each thread by use of -Xss option
- Use call backs for synchronous sends
- Use LevelDB!

ActiveMQ – Horizontal Scaling



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Apache ActiveMQ - Scaling

Horizontal Scaling: Increase load capacity using many brokers

- Use ActiveMQ Networks
- Messages are forwarded between brokers with interested consumers
- Networks lift the limits of using a single machine

- Problems:
  - Complex topologies can lead to non-optimal message routing
  - Orphaned Messages on failure (use networks and clusters)

Apache ActiveMQ - Scaling

Horizontal Scaling – client-side partitioning

Hybrid of Vertical and Horizontal Scaling

- Multiple broker nodes are used by the clients
- Brokers are NOT networked
- The client application send message to different brokers, typically based on some defined partitioning of the data.

Pros

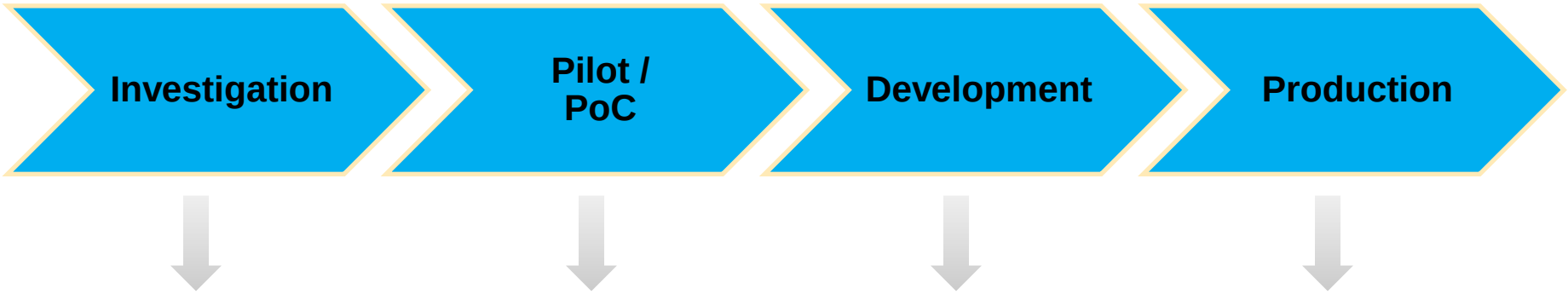
- You can use all the tuning techniques used in Vertical scaling
- Have better Horizontal scalability than using Network Of Brokers (Less broker cross talk)

Cons

- Added complexity required on the end user Application

FuseSource Knows How To Build Enterprise Apps

Help throughout the software development lifecycle…



Get started

- *training videos*
- *webinars*
- *tutorials*
- *documentation*
- *white papers*

Try it out

- *tech overviews*
- *training*
- *project planning*
- *pilot workshop*
- *pilot subscription*

Build right

- *dev. subscription*
- *arch. workshop*
- *best practices*
- *QoS development*
- *training*

Deploy safely

- *prof. subscription*
- *health check*
- *perf. workshop*
- *HA workshop*
- *training*

Available for Free

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Embedding Apache Camel

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ActiveMQ with embedded Camel

- Co-location: fail-fast
- Advanced routing in the Broker – reduce latency and improve performance

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ActiveMQ with embedded Camel: import camel into ActiveMQ broker config:

```
<beans>
  <broker brokerName="testBroker"  xmlns="http://activemq.apache.org/schema/core">
   <transportConnectors>
     <transportConnector uri="tcp://localhost:61616"/>
   </transportConnectors>
  </broker>
  <import resource="camel.xml"/>
</beans>
```

ActiveMQ with embedded Camel: Setup Camel Context in usual way

```
<camelContext errorHandlerRef="errorHandler" xmlns="http://camel.apache.org/schema/spring">
   <route>
      <from uri="activemq:queue:test.queue"/>
      <choice>
         <when>
            <xpath>$foo = 'bar'</xpath>
            <to uri="activemq:topic:topic.bar"/>
         </when>
         <when>
            <xpath>$foo = 'cheese'</xpath>
            <to uri="activemq:topic:topic.cheese"/>
         </when>
         <otherwise>
            <to uri="activemq:topic:topic.all"/>
         </otherwise>
      </choice>
   </route>
</camelContext>
```

Introducing FuseMQ Enterprise

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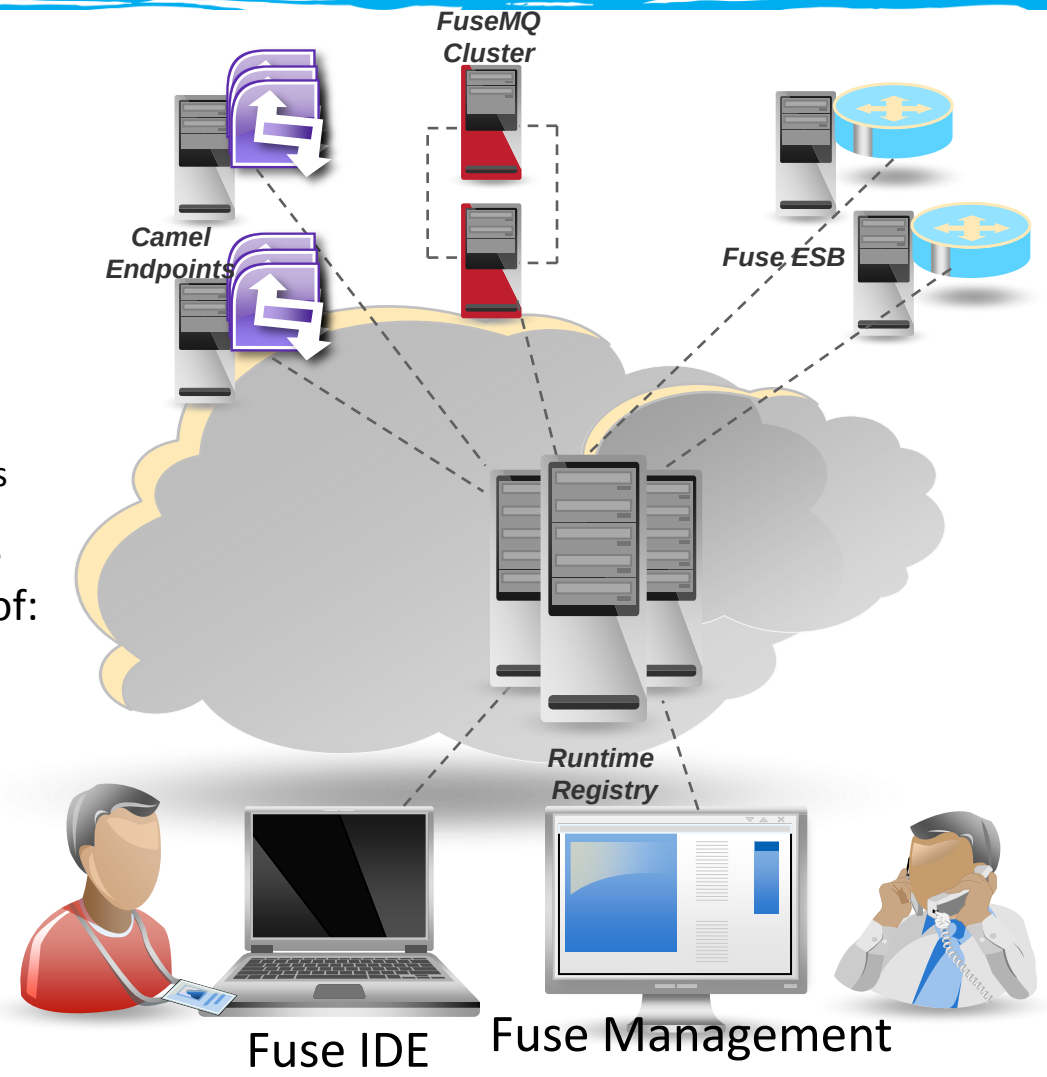
Why Fuse Fabric ?

- Configuration of Apache ServiceMix and Apache ActiveMQ is complex
- Enterprise deployments of our software requires a lot of upfront knowledge, and its easy to get wrong
- Enterprises need to deploy across different environments, on-premise, on a private cloud, on a public cloud and all of the above
- Enterprise deployments need location transparency, and support of failover of endpoints

Fuse Fabric – Key Features

- Support Hybrid deployments – on premise, on cloud, on both
  - Endpoints can be relocated
  - Endpoints can be load balanced
  - Endpoints can be elastic
  - Endpoints can be highly available
- Distributed Configuration
  - Configuration has to be accessed across multiple domains
  - Configuration has to be highly available
- Runtime Registry – allows discovery of:
  - services
  - Endpoints
  - FuseMQ message brokers
- Distributed Management
  - Easy elastic scaling of services
  - Monitoring and Control of resources



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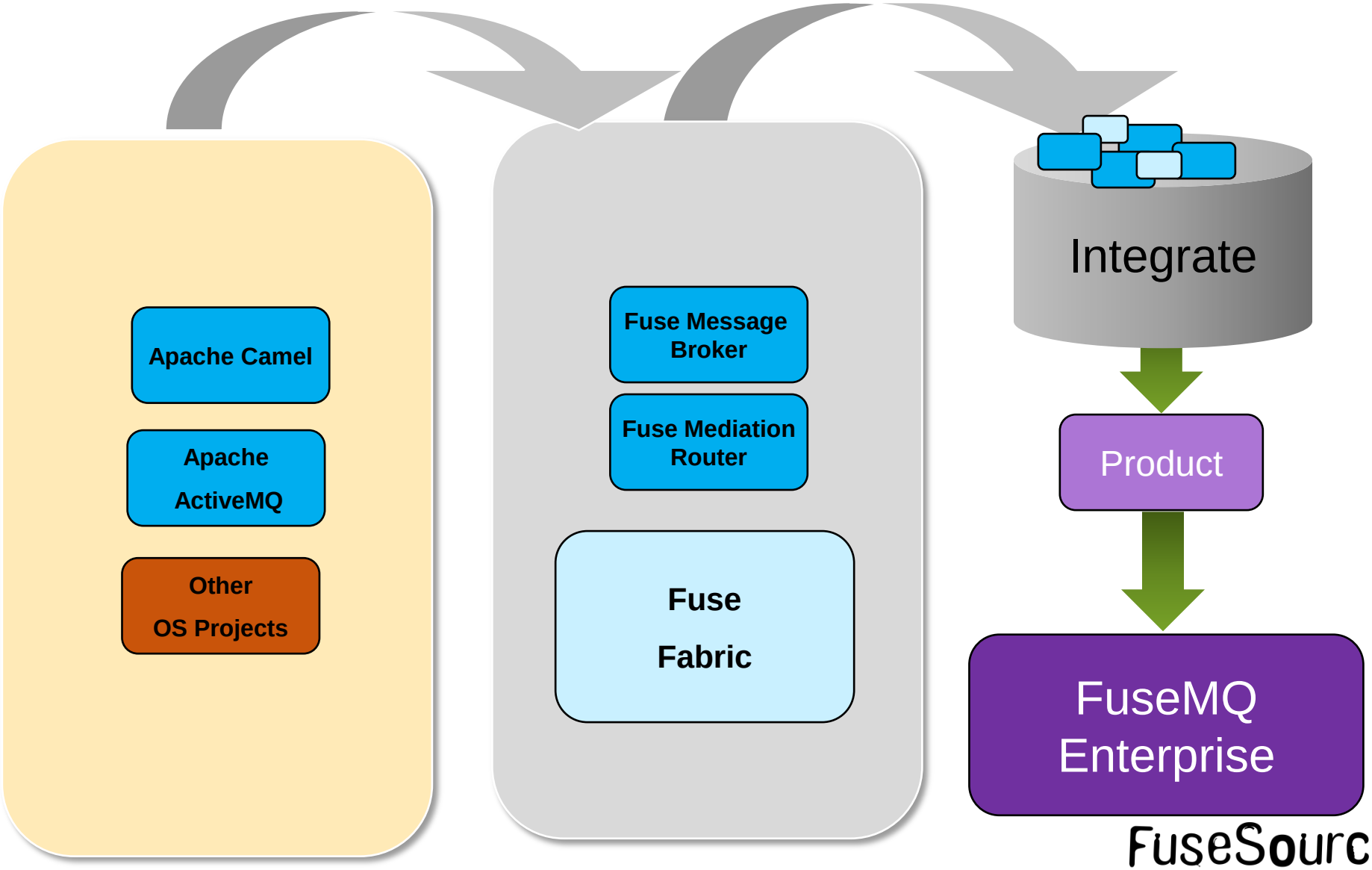
FuseSource Productization of Open Source



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FuseMQ Enterprise Use cases

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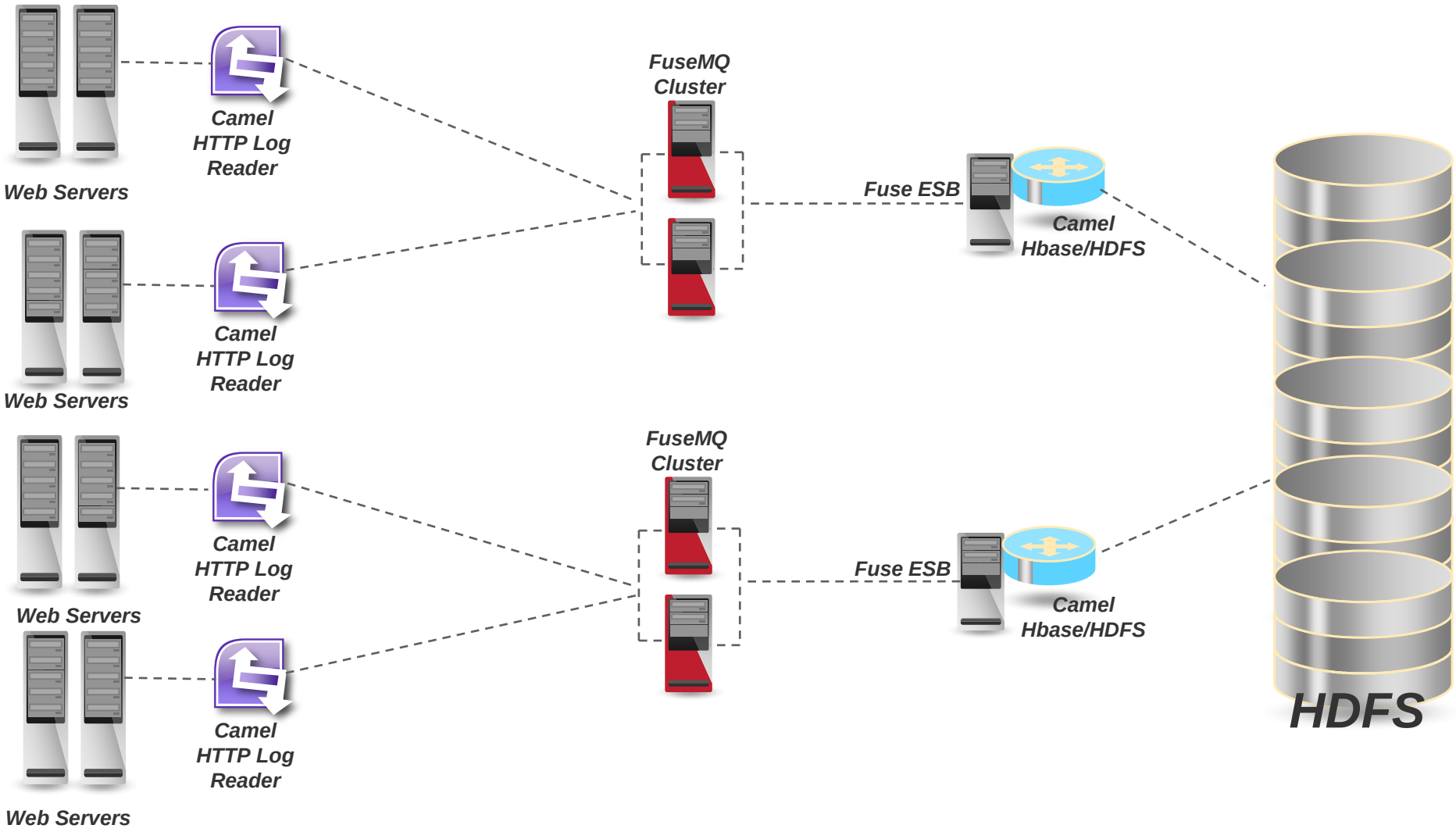
Ingestion for BigData Architecture:



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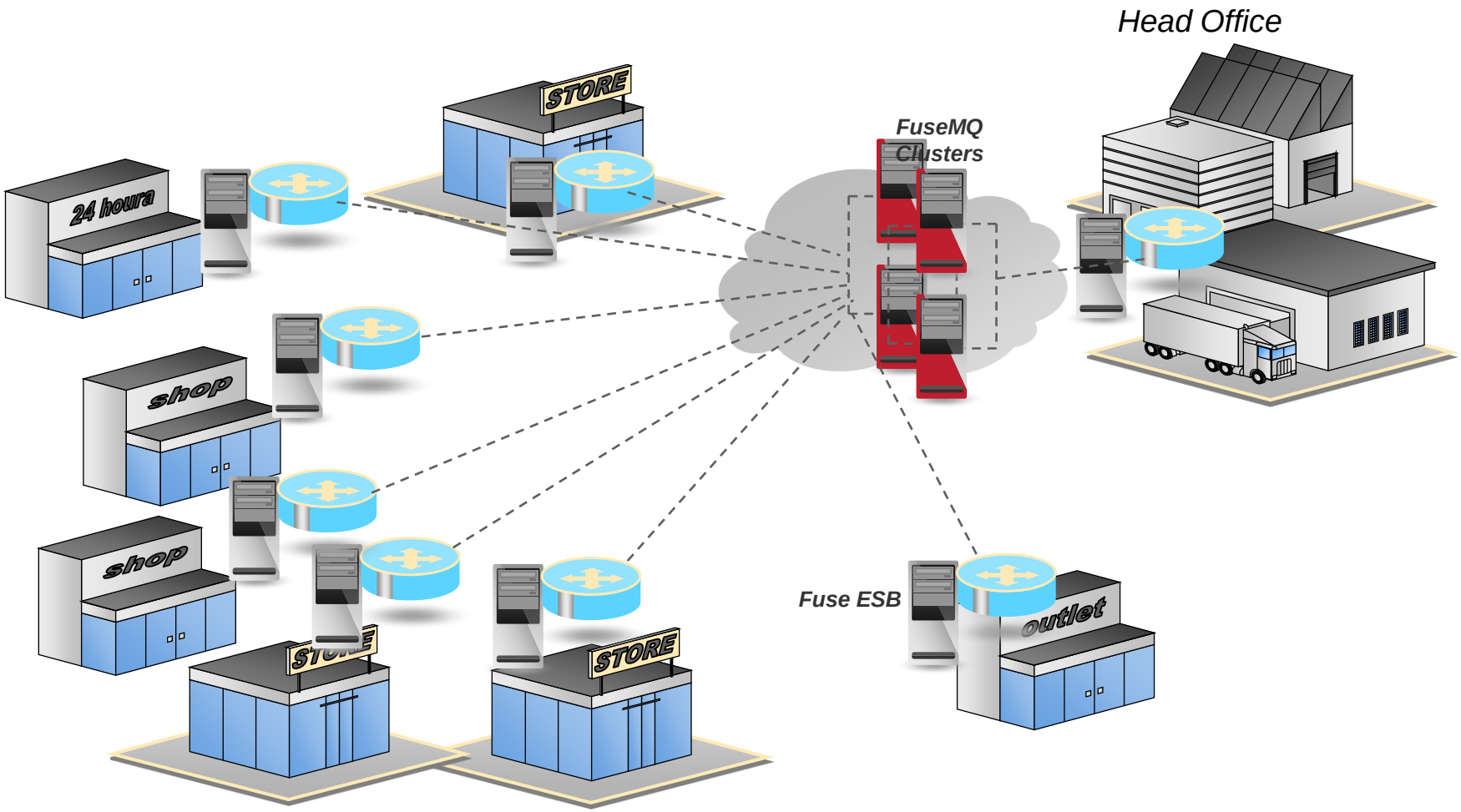
Example of Distributed Application Integration



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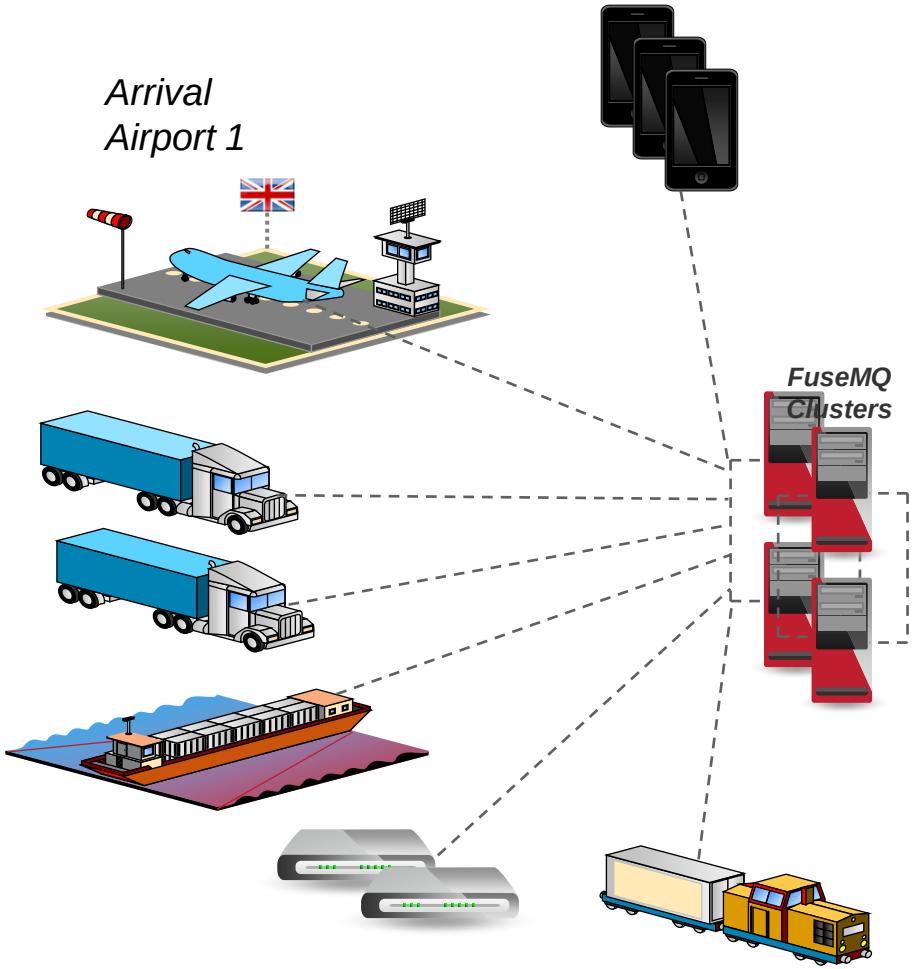
M2M Deployments

MQTT

- *MQTT support in Fuse Message Broker 5.6 and FuseMQ Enterprise 7.1*
- *MQTT protocol is extremely light weight – with many M2M clients*
- *Using Fuse Messaging products – seamless integration between MQTT, Stomp, OpenWire (JMS, C++/C) and more (AMQP in the future).*

Machine-to-Machine (M2M) solutions such as industrial control, smart buildings, asset tracking, traffic control and healthcare monitoring, are an essential and integral part of nearly all industry, enterprise and daily life. Inherent to M2M is the need to connect objects in the physical world, via sensors, actuators and other devices, into monitoring, control, business, and consumer software systems, often over constrained wireless networks.



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Deploying FuseMQ in enterprise using Fuse Fabric

Dejan Bosanac
FuseSource

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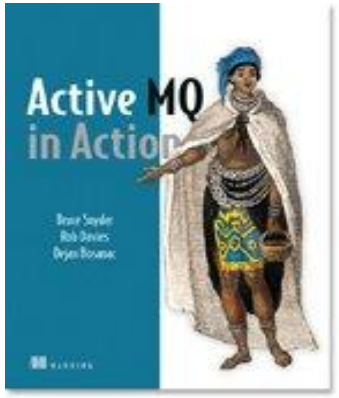
Presenter: Dejan Bosanac

- Senior Software Engineer at FuseSource - http://fusesource.com
- Apache ActiveMQ committer and PMC member
- Co-author of ActiveMQ in Action
- Blog:
  - http://www.nighttale.net/
- Twitter:
  - http://twitter.com/dejanb



Agenda

- Problems of large enterprise deployments
- Fuse Fabric in nutshell
- FuseMQ and Fuse Fabric
  - Creating brokers
  - Connecting
  - Topologies
- Fuse Management Console

Problems of large deployments

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Problems – Deploying and maintenance

- Main problems
  - Installing brokers on multiple hosts
    - ssh, untar, set directories and environment
  - Setting configuration manually for every broker
    - copying xml config, tweaking, testing
  - Updating configuration across cluster
  - Upgrading brokers

It's very tedious and error-prone process

Problems – Traditional best-practice tips

- Keep XML as a template and configure node-specific details through properties
- Keep configuration in SVC system (git, svn, ...)
- Keep configuration separate from installation for easier upgrades

Deployment with Fuse Fabric moves it to the next level

Problems - Clients

- Topology is very “static”
- Clients need to be aware of topology
- Clients need to know broker locations
- Changes are not easy as clients need to be updated
- Adding new resources (brokers) requires client updates
- Not suitable for “cloud” deployments

Fuse Fabric makes deployments more “elastic”

Fuse Fabric in a nutshell

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Fuse Fabric in a nutshell

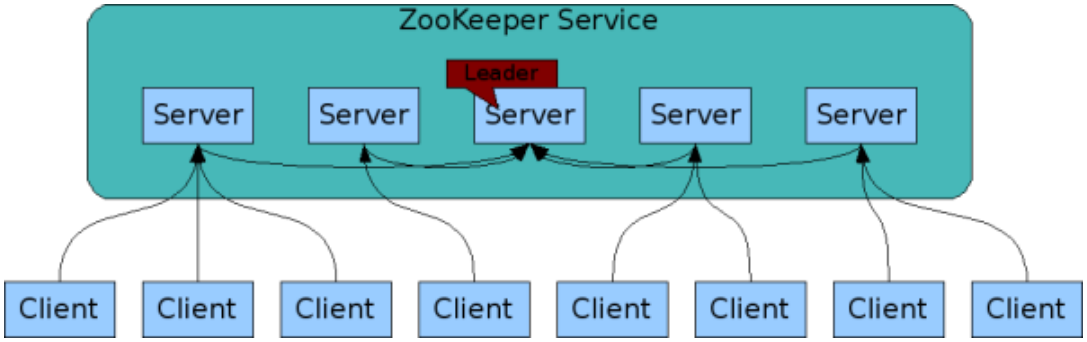
- How Fabric can help?
  - It provides centralized distributed broker configuration
  - It provides centralized distributed broker registry
  - Uses OSGi and Apache Karaf for easy spawning new broker instances
  - It provides additional tools for centralized configuration and monitoring (Fuse Management Console)

Fuse Fabric in a nutshell

- Installation
  - Features and bundle versions centrally stored and managed
  - Easy installation and upgrade
- Configuration
  - Stored in one place
  - Versioned
- Discovery
  - All brokers registered in central registry
  - Allows clients to connect without knowing broker locations
  - Allows easy creation of advanced topologies

Fuse Fabric Architecture

- Zookeeper

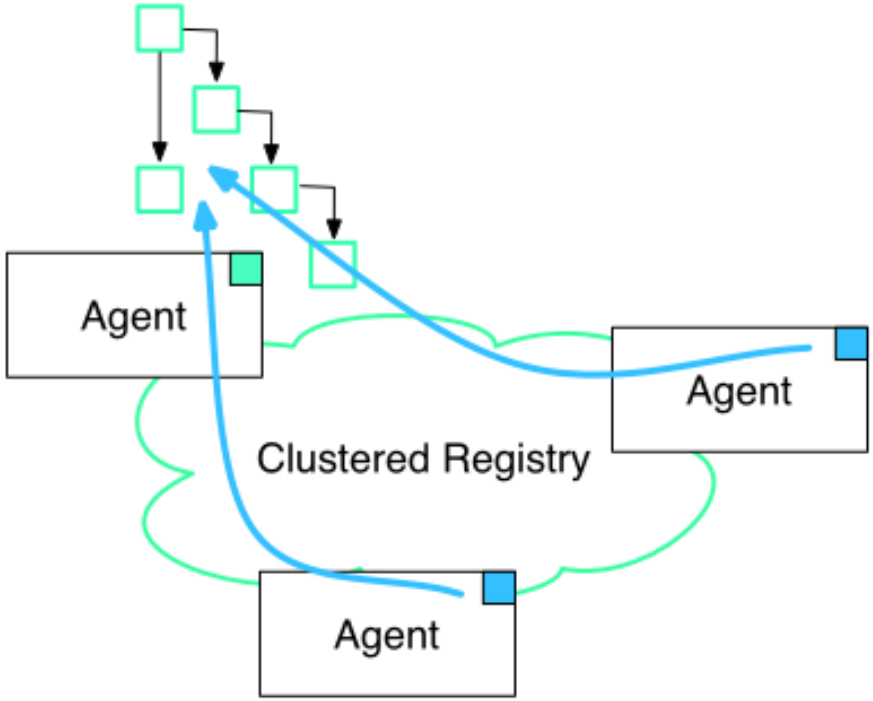


  - Replicated in-memory tree
  - Similar to file system
  - Highly-available
  - Distributed
  - Support network split
  - Proven track record

Ideal for distributed configuration and locking

Fuse Fabric Architecture

- Containers
  - Apache Karaf instances provisioned through central registry (Zookeeper)



Fuse Fabric Architecture

- Profiles:
  - Zookeeper nodes with conventional names
  - OSGi configuration for the node (so we know what features and bundles should be used)
  - Other configuration (**centralized broker configuration**)
  - Versioned

Fuse Fabric - Profile

```
FuseFabric:karaf@root> profile-display default
Profile id: default
Version   : 1.0
Parents   :
Associated Containers :

Container settings
--------------------------
Repositories :
        mvn:org.fusesource.fabric/fuse-fabric/7.0-SNAPSHOT/xml/features

Features :
        fabric-agent
        karaf
        fabric-jaas
        fabric-core
```

Fuse Fabric - Profile

Agent Properties :

org.ops4j.pax.url.mvn.repositories =
http://repo1.maven.org/maven2,
http://repo.fusesource.com/nexus/content/repositories/releases,
http://repo.fusesource.com/nexus/content/groups/ea,
http://repository.springsource.com/maven/bundles/release,
http://repository.springsource.com/maven/bundles/external,
http://scala-tools.org/repo-releases
org.ops4j.pax.url.mvn.defaultRepositories =
file:${karaf.home}/${karaf.default.repository}@snapshots,
file:${karaf.home}/local-repo@snapshots

Configuration details

PID: org.fusesource.fabric.zookeeper
zookeeper.url ${zk:root/ip}:2181

FuseMQ and Fuse Fabric

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FuseMQ features

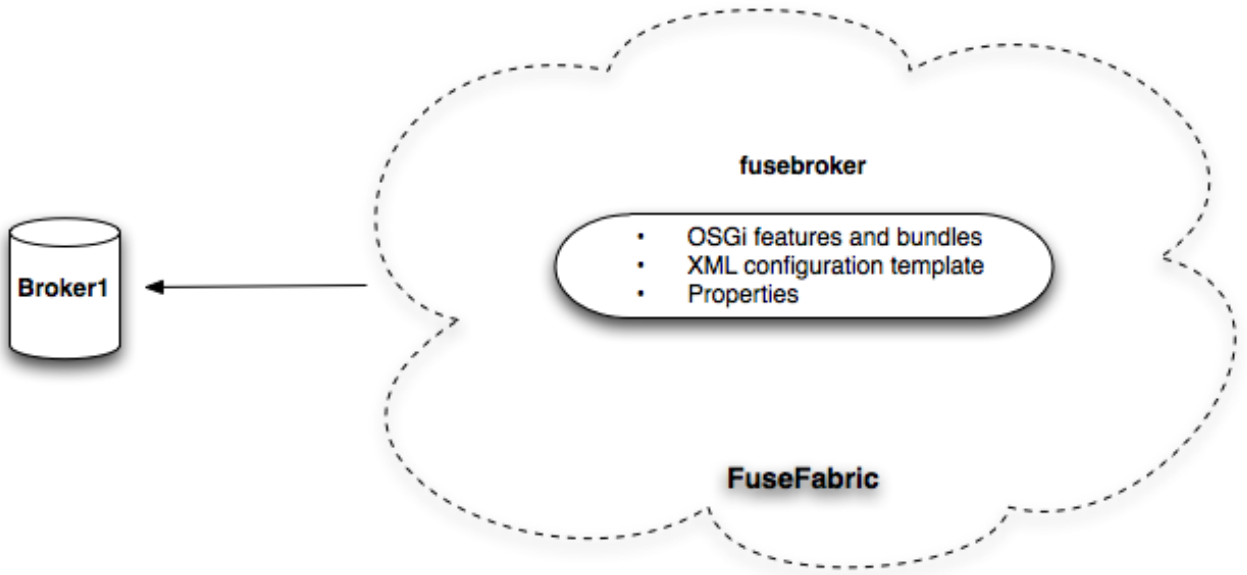
- mq-base profile
  - Defines OSGi features and bundles to be installed
  - Defines basic broker settings
- mq-create command
  - Helper command for creating brokers
  - Creates an new profile based on mq-base
  - Optionally creates new containers
  - Assigns the profile to containers (essentially starts the broker)

MQ – Creating broker

FuseFabric:karaf@root> mq-create --create-container broker1 fusebroker

MQ profile fusebroker ready

Successfully created container broker1



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MQ Profile

```
FuseFabric:karaf@root> profile-display fusebroker
Profile id: fusebroker
Version   : 1.0
Parents   : mq-base
Associated Containers : broker1

Configuration details
---------------------------
PID: org.fusesource.mq.fabric.server-fusebroker
  standby.pool default
  connectors openwire
  broker-name fusebroker
  data data/fusebroker
  config zk:/fabric/configs/versions/1.0/profiles/mq-base/broker.xml
  group default
```

MQ – Assigning profile

```
FuseFabric:karaf@root> container-create-ssh --host 192.168.1.106
--user dejanb --password xxx broker1
```

```
FuseFabric:karaf@root> mq-create --assign-container broker1 fusebroker
MQ profile fusebroker ready
Profile successfully assigned to broker1
```

MQ - Benefits

- What did we achieve with this?
  - We can easily create new brokers with the same profiles
  - We can create new profile version with updated broker version and/or changed configuration
  - We can easily update all (or some) brokers by applying the new profile

MQ Profile - Management

- Create a new profile version
  - with upgraded bundles
  - and configuration changes
- Try it out on a non-production container
- Deploy to one or a few production containers
- Roll the full upgrade
- Easy rollback if anything goes wrong

Broker Registry

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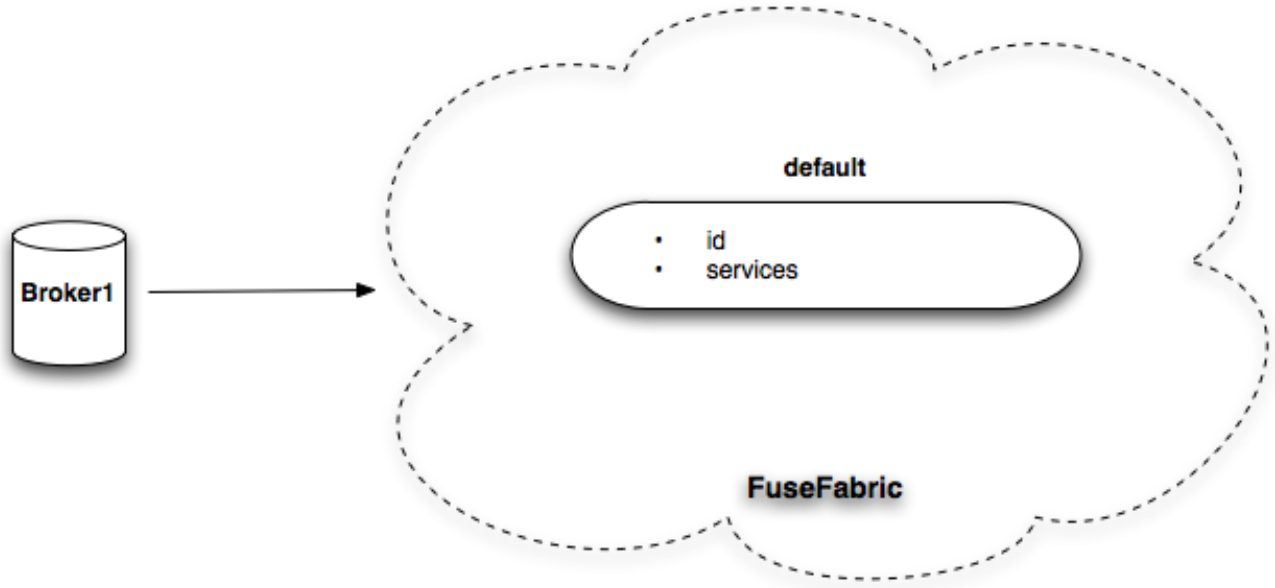
Broker Registry

- Brokers are organized in groups (clusters)
  - Cluster can have any number of brokers (with different names)
  - Put in “default” group if not specified

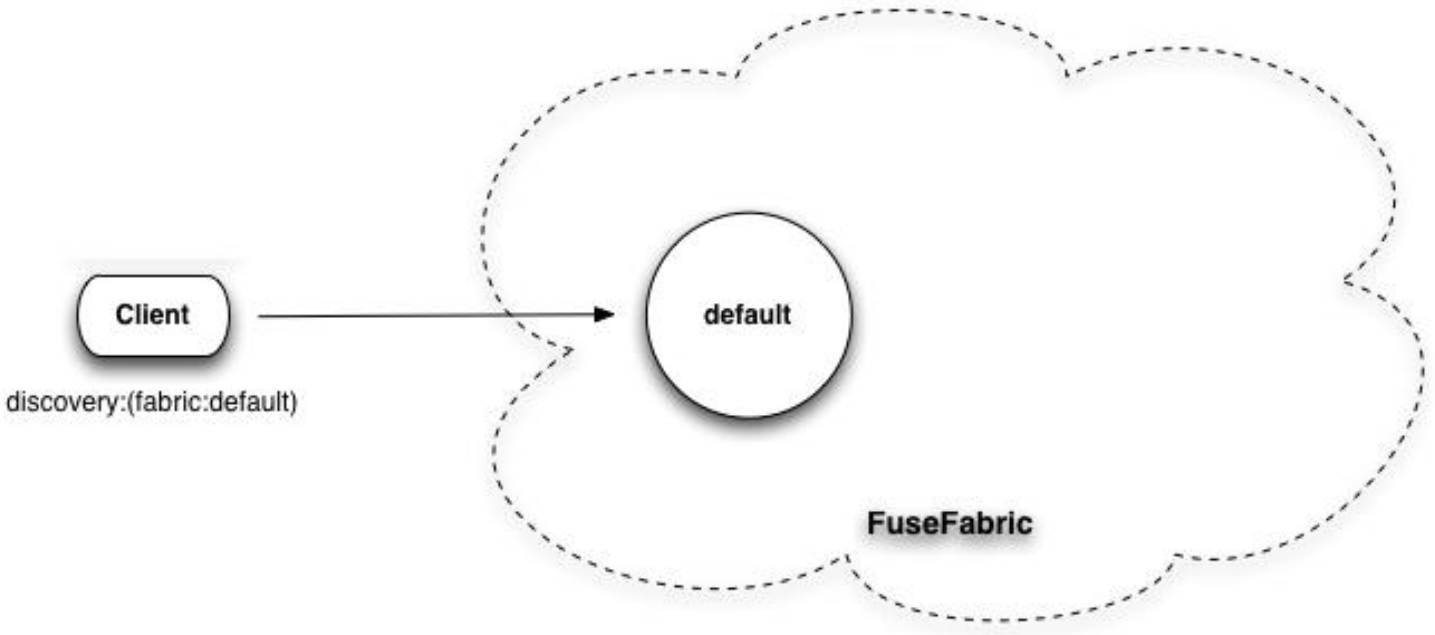


Connecting to the Broker

- Clients need to have ZooKeeper URL
- There is a new discovery protocol (called fabric)
- Connecting is as easy as defining the group

Connecting - Factory

```
ActiveMQConnectionFactory factory =
        new ActiveMQConnectionFactory("discovery:(fabric:default)");
```



Connecting - Reconnecting

- Clients don’t need to know brokers location
- Works like a failover transport
- Supports options for tuning reconnecting options

discovery:(fabric:default)?reconnectDelay=1000&useExponentialBackOff=false

Connecting - Camel

```
<camelContext xmlns="http://camel.apache.org/schema/spring">
        <!– Do your magic here -->
</camelContext>

<bean id="activemq"
  class="org.apache.activemq.camel.component.ActiveMQComponent">
  <property name="brokerURL" value=”discovery:(fabric:discovery)"/>
</bean>
```

Topologies

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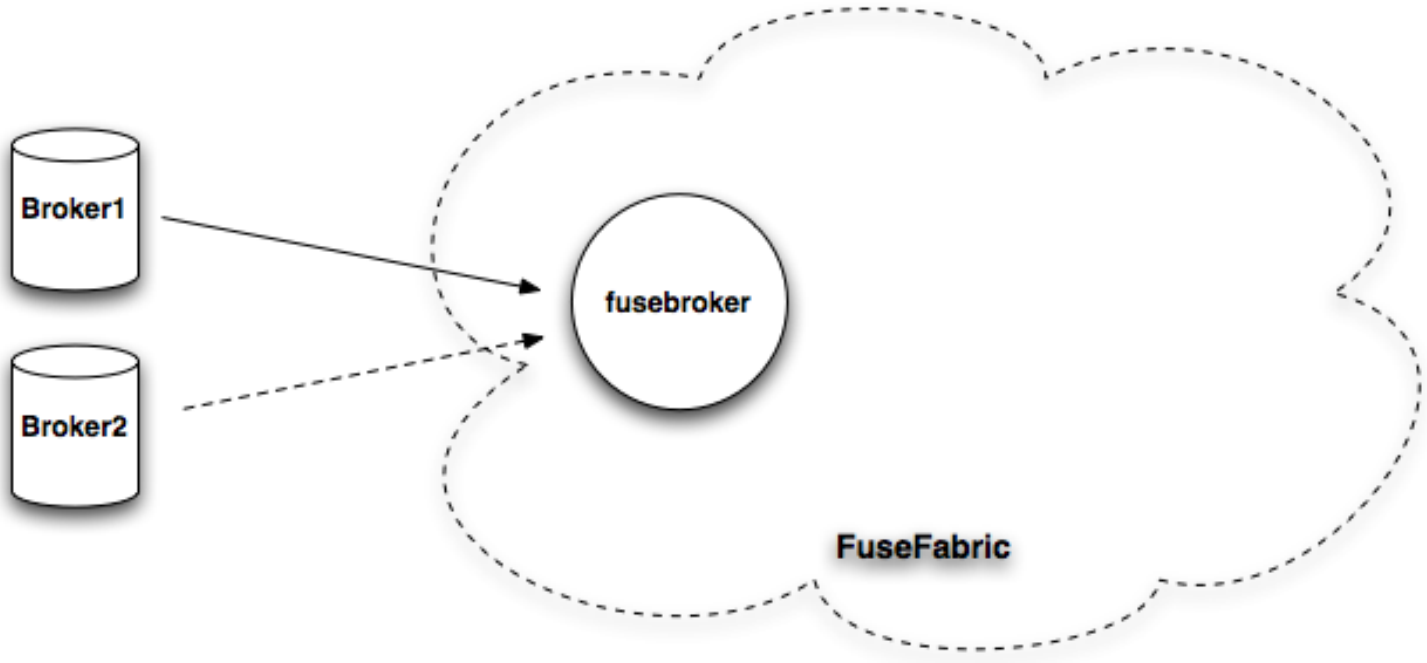
Master/Slave

- Create master slave configuration by starting multiple brokers with the same name (in the same group)
  - First one stared becomes a master
  - Everyone else is a slave
  - Locked on Zookeeper node
  - When master dies, a first slave to get a lock becomes next master

Master/Slave

FuseFabric:karaf@root> mq-create --create-container broker1 fusebroker

FuseFabric:karaf@root> mq-create --create-container broker2 fusebroker



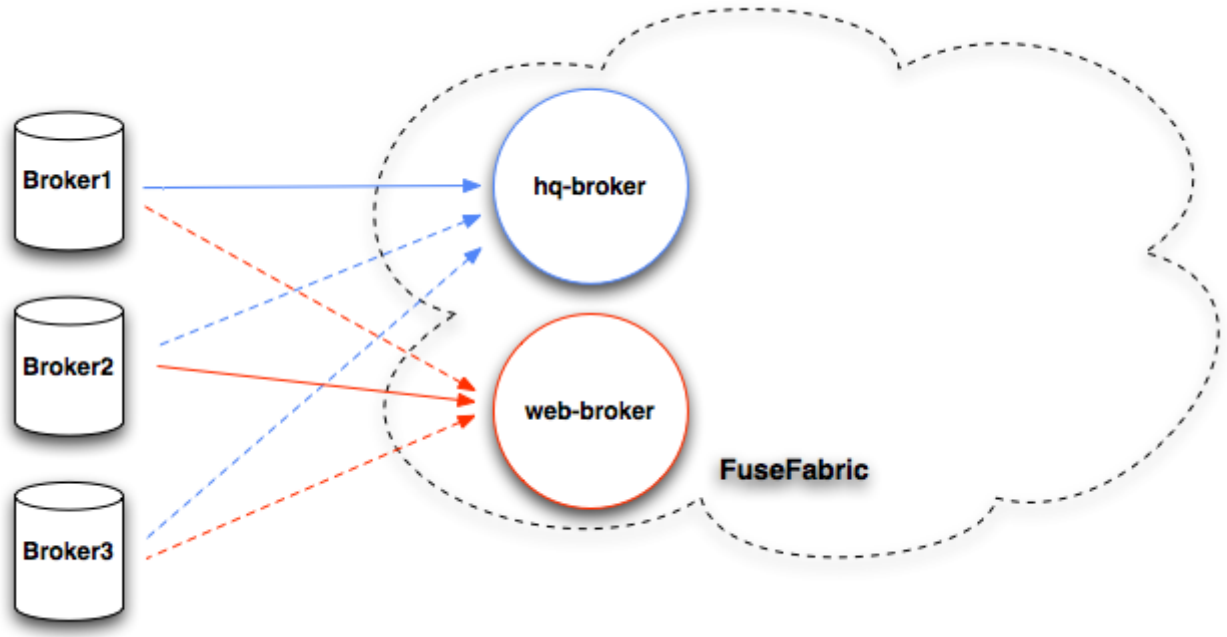
Master/Slave

- No more relying on shared storage locking
- You'll still need shared storage for preserving the state among brokers
- Easy creating non-persistent master slave configurations
- Clients again don't need to know topology as fabric discovery will do that work

Master/Slave

- Multiple master slave over the same containers
  - Resource utilization

mq-create --create-container broker1,broker2,broker3 hq-broker
mq-create --assign-container broker1,broker2,broker3 web-broker



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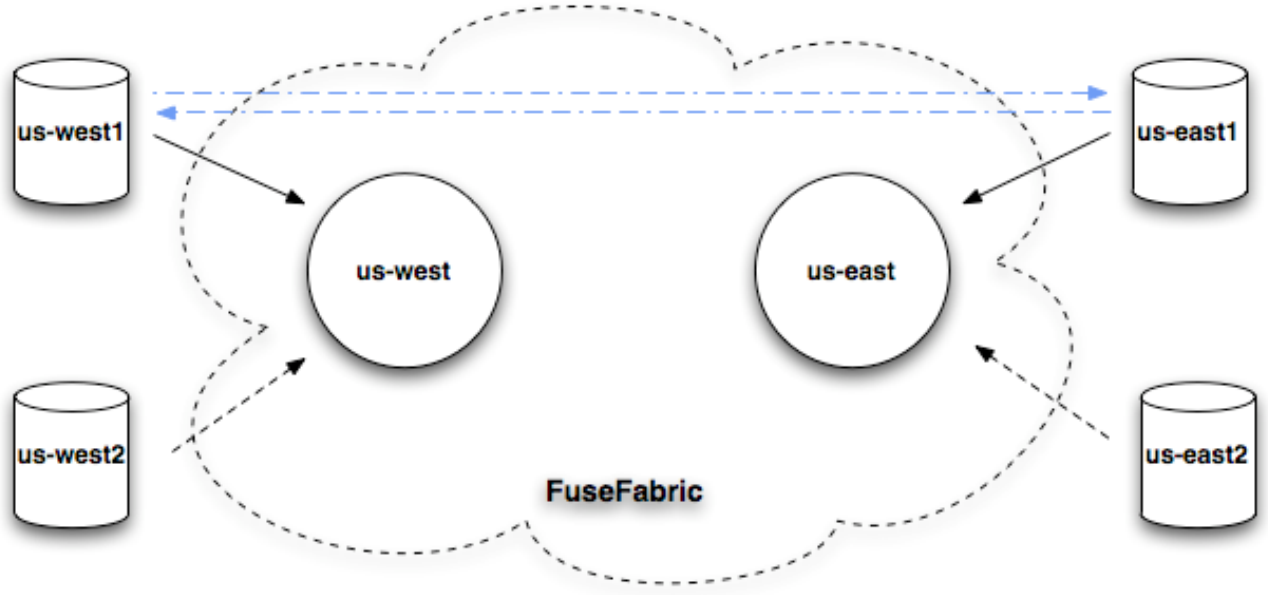
Networks

- Controlled through profile
- Uses fabric discovery, just as clients

mq-create --group us-east --networks us-west --create-container us-east1,us-east2 us-east

mq-create --group us-west --networks us-east --create-container us-west1,us-west2 us-west



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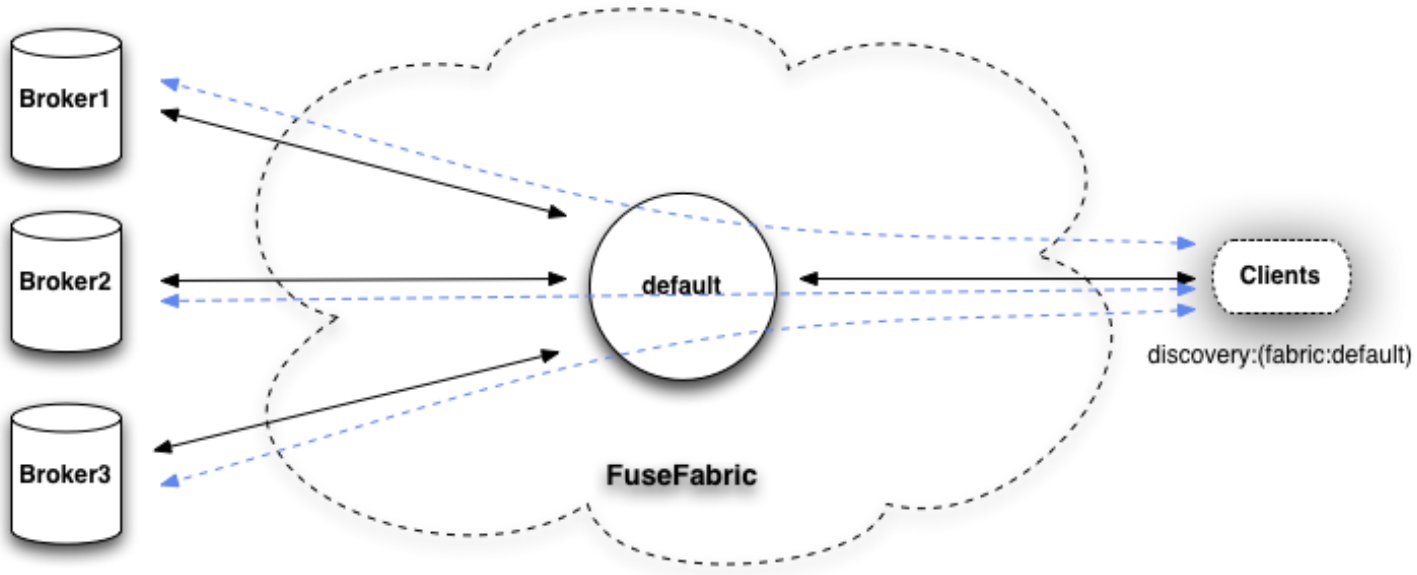
Elastic clusters

- Request-reply pattern over JMS
- Load Balance Traffic
- Non-persistent, not-connected brokers
- Elastic cluster
  - Allow adding new brokers, without updating clients
  - Allow rebalancing of clients

Elastic clusters

mq-create --create-container broker1 broker1
mq-create --create-container broker2 broker2
mq-create --create-container broker3 broker3



Tooling

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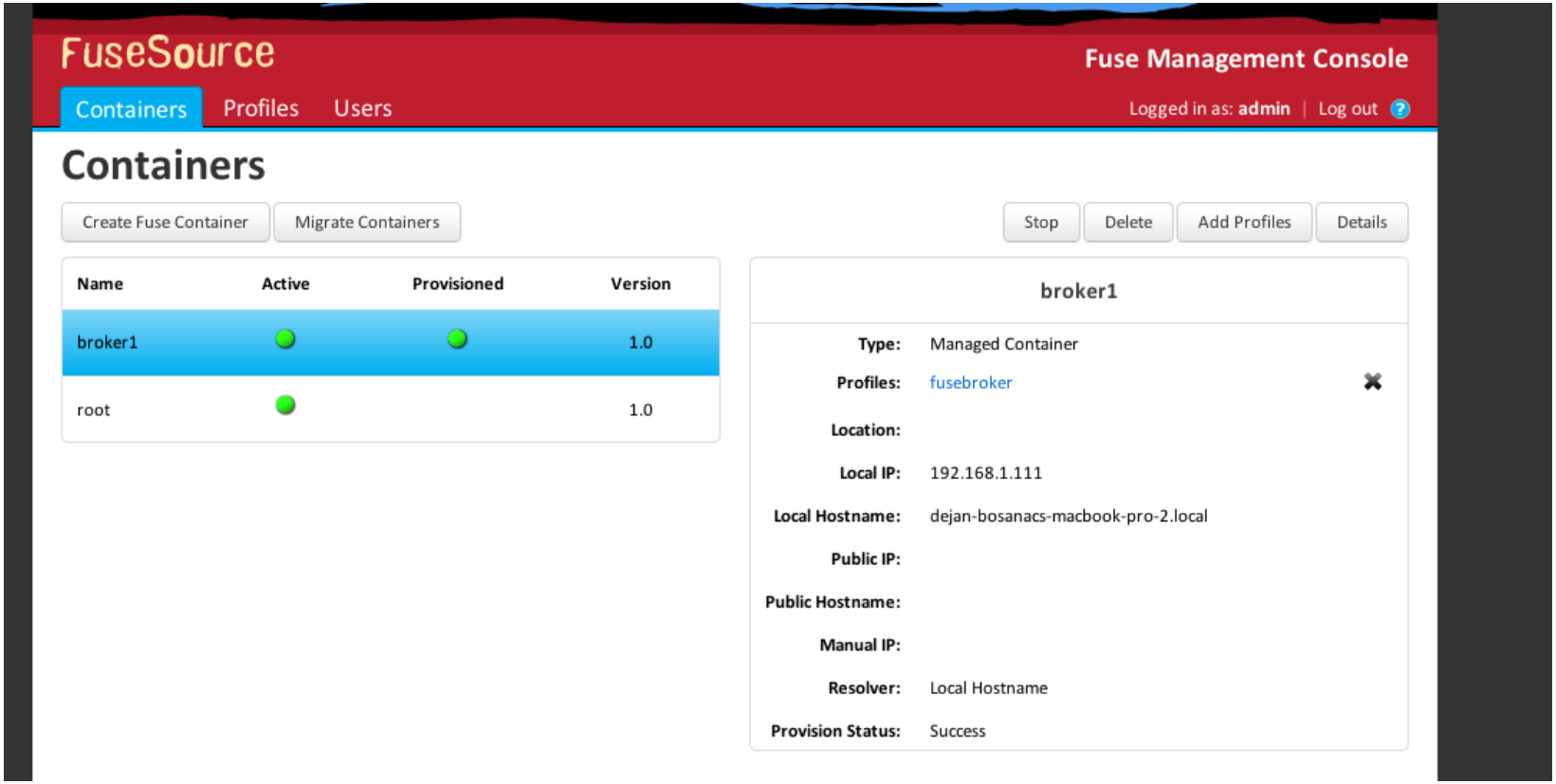
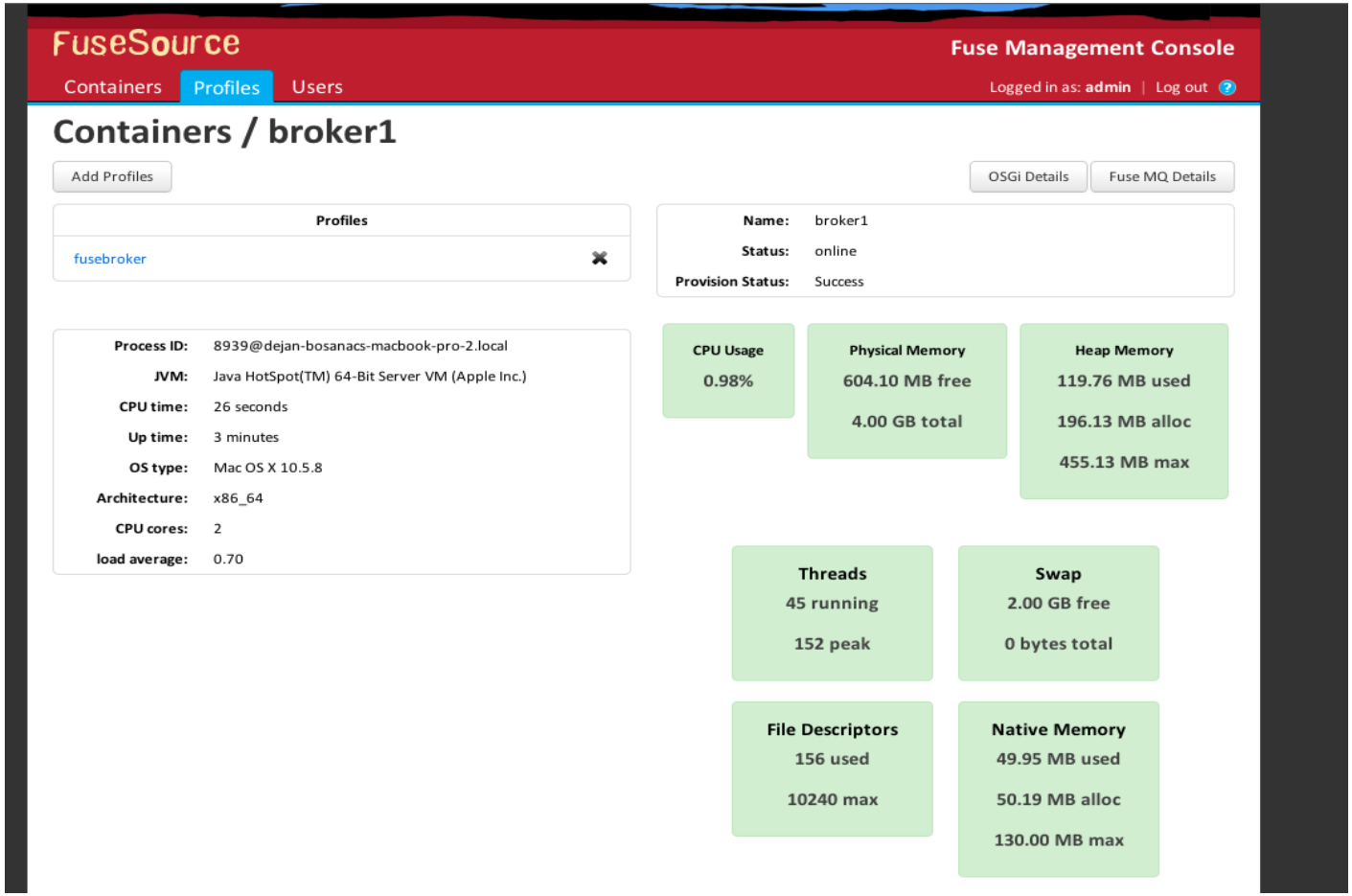
Fuse Management Console

- Centralized Unified Console
- Web UI for managing and monitoring infrastructure
- Uses Fabric to discover resources
- Features
  - Container Management
  - Profile Management
  - Centralized Security
  - Centralized Monitoring

FMC – containers



FMC – Container



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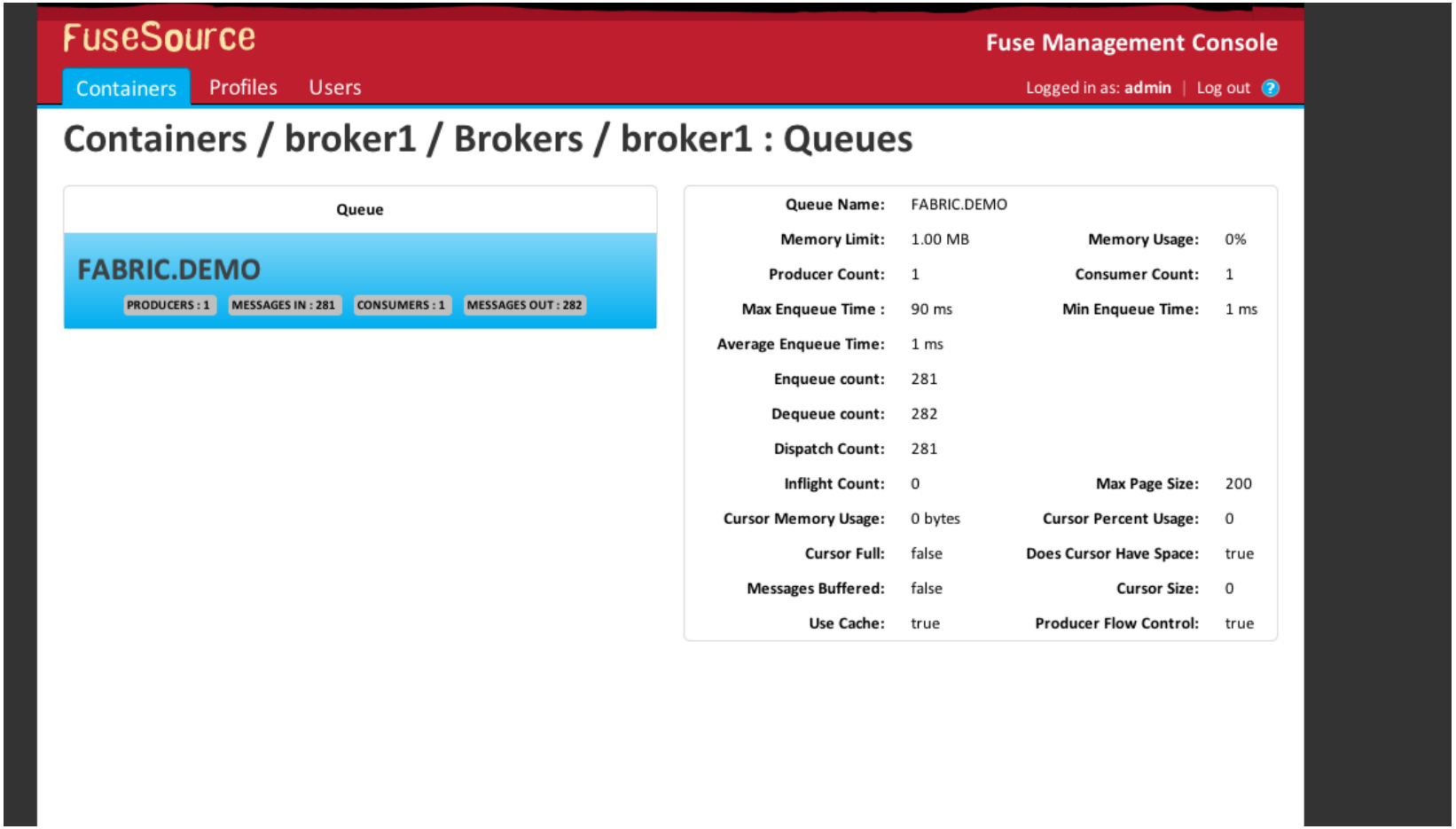
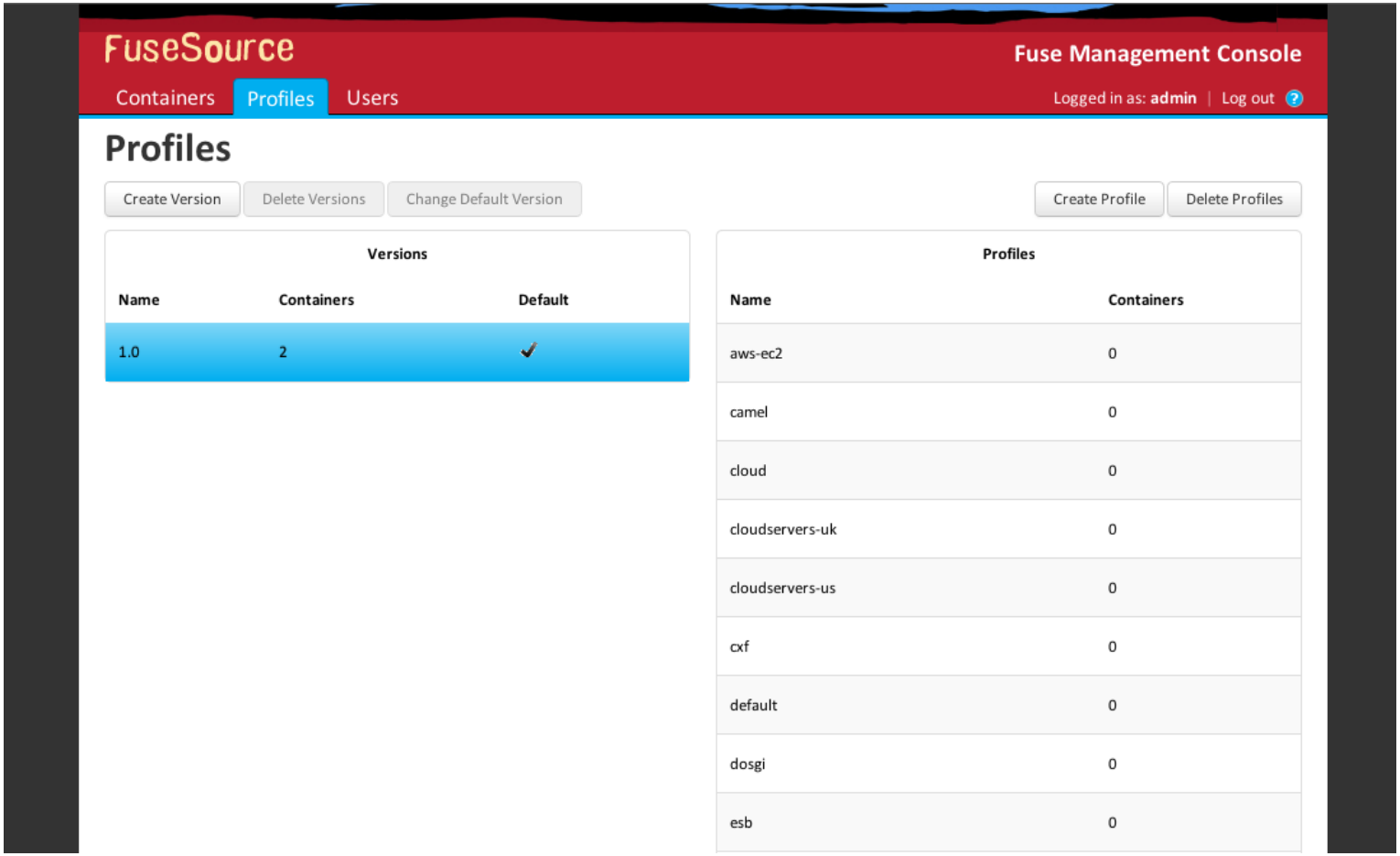
FMC – broker view



FMC - Profiles



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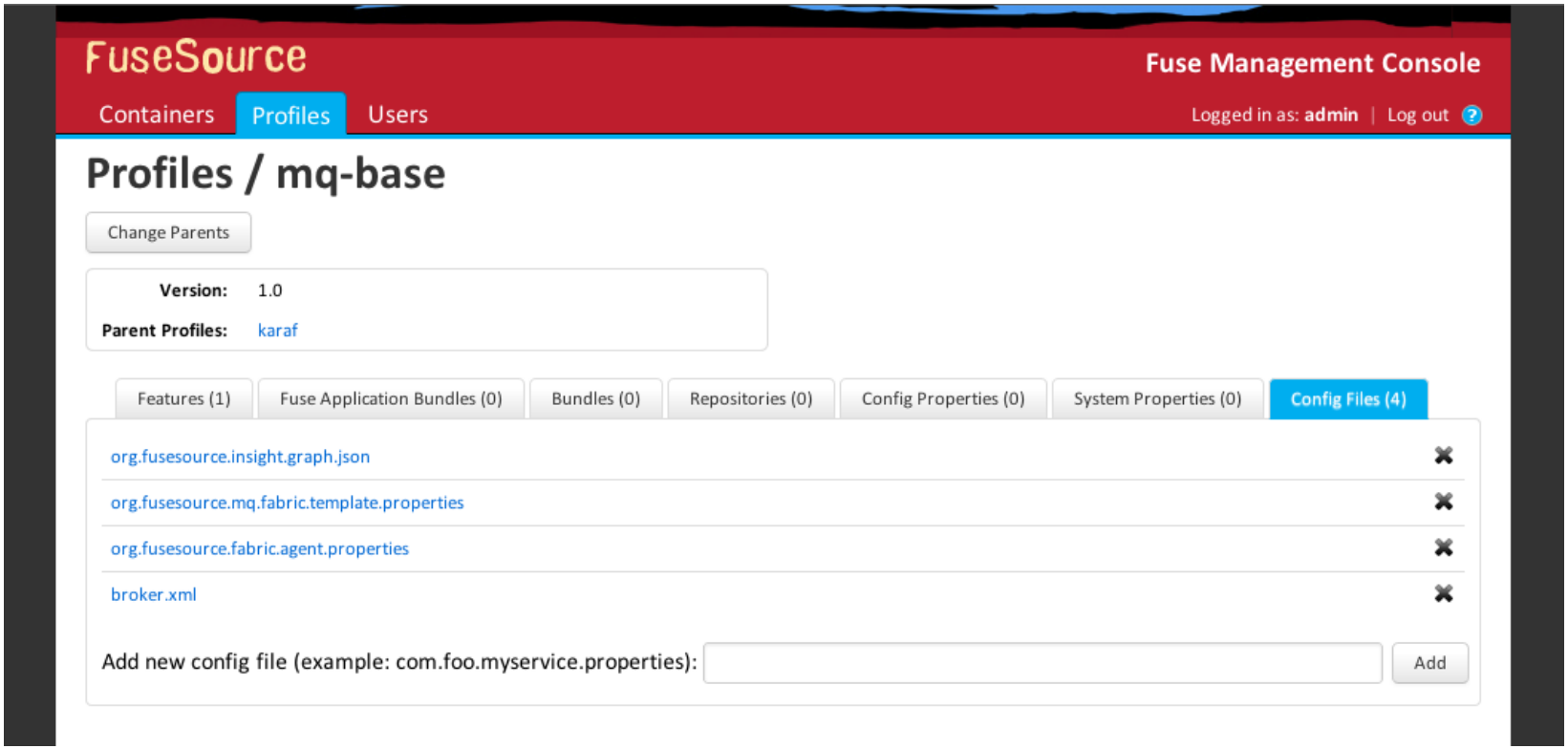
FMC - Profile



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Future

- More things for developers
  - Make it even easier to write applications for Fuse Enterprise
- More things for operations
  - Visualization of clusters
  - Centralized logging (collect and search all logs centrally)

Conclusion

- Helps with complex and large deployments
- Use central registry for distributed configuration and locking
- Make clients location agnostic of brokers (needed for cloud deployments)
- Easy upgrades and updates
- Support for incremental patching
- Tools

Questions

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