ENTERPRISE MESSAGING AND JBOSS A-MQ

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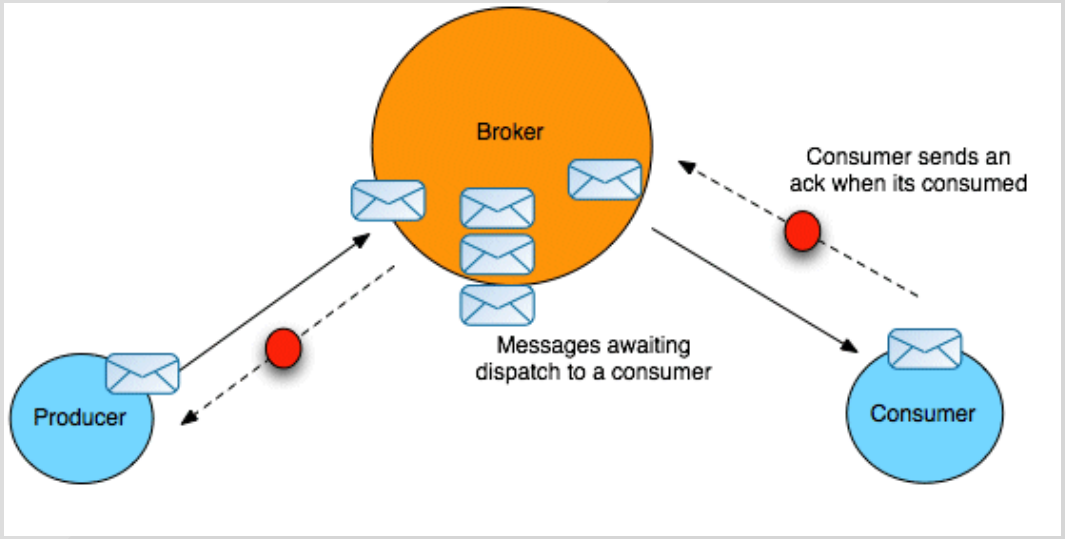
LECTURE OUTLINE

- Messaging systems
  - JMS specification
  - JMS API
- JBoss A-MQ
  - JBoss A-MQ and Apache ActiveMQ
  - Protocols
  - topologies
- Apache Artemis

ENTERPRISE MESSAGING

- data exchange between applications
- Message oriented middleware (MoM)
  - Message broker servers as mediator between communicating parties


Broker
Consumer sends an ack when its consumed
Messages awaiting dispatch to a consumer
Producer
Consumer

BENEFITS OF MESSAGING SYSTEM

- Asynchronous communication
- Loose coupling
- scalability
- reliability
- message routing and transformation

JMS SPECIFICATION

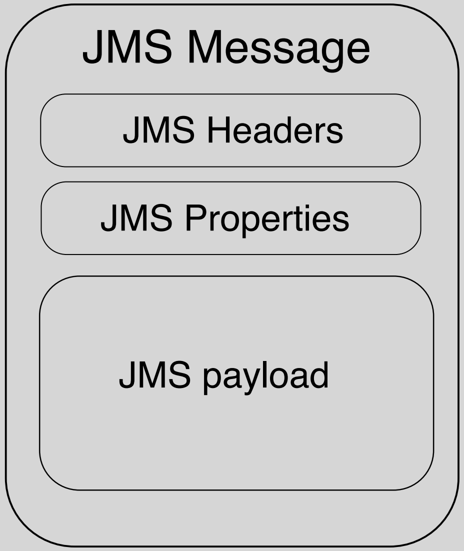
- goal is to:
  - provide messaging functionality to the java applications
  - maximizes portability between messaging products
  - define common messaging concepts
- JMS is not messaging system!
- JMS provides API for messaging products
- JMS does not address:
  - load balancing
  - fault tolerance
  - administration
  - wire protocol
  - security

BASIC CONCEPTS

- JMS provider
- (non) JMS client
    - producer/consumer
- JMS domains
- JMS destinantion
- JMS Message

MESSAGE STRUCTURE

- Headers
  - key value pairs
  - two types (differes only semanticaly):
    - default headers
    - custom properties



MESSAGE HEADERS LIST

Header name	**meaning**
JMSDestination	destination on the broker
JMSDeliveryMode	persistent or nonperistent delivery mode
JMSExpiration	message will not be delivered after expiration
JMSMessageID	Identifiaction of the message
JMSPriority	Number 0 - 9 (0-4 low, 5-9 high priority). Advise only
JMSTimestamp	Time when the message is handed to provider for send
JMSCorrelationID	links message to another one
JMSReplyTo	Destination for reply
JMSRedelivered	Contains true if the message was likely redelivered

JMS PROPERTIES

- Custom
  - Used for application specific data
- JMS defined
  - JMSX prefix in the name (e. g. JMSXAppID, JMSXConsumerTXID, ...)
- Provider specific
  - JMS_<vendor_name>
  - typically used in non-JMS clients

MESSAGE SELECTORS

- Message filtering based on properties
- Condition based on subset of SQL92

```
PRICE <= 1000 AND COLOR = 'RED'
```

```
FLIGHT_NUMBER LIKE 'N14%'
```

MESSAGE CONTENT

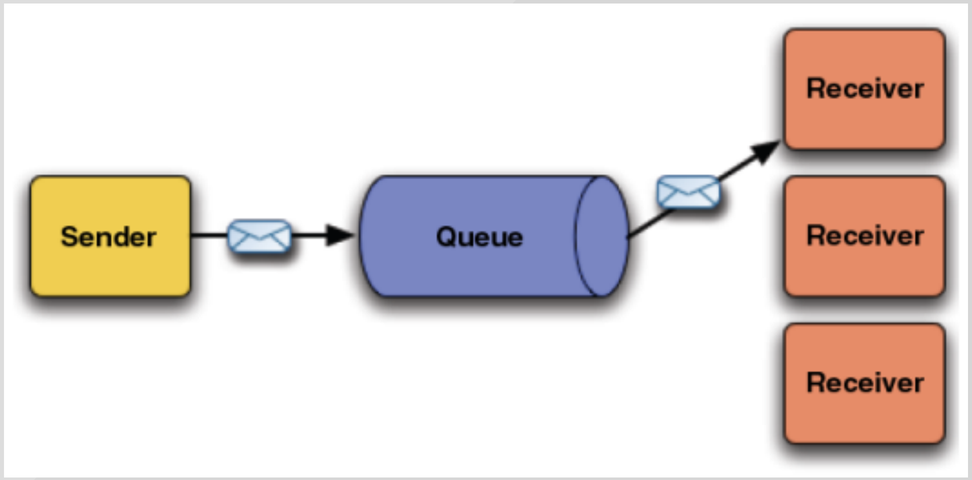
- There are several types of message defined in JMS:
  - TextMessage
  - MapMessage
  - BytesMessage
  - StreamMessage
  - ObjectMessage

COMMUNICATION DOMAINS

- Communication type:
  - Point-to-point (PTP)
  - Publish/Subscribe (Pub/Sub)

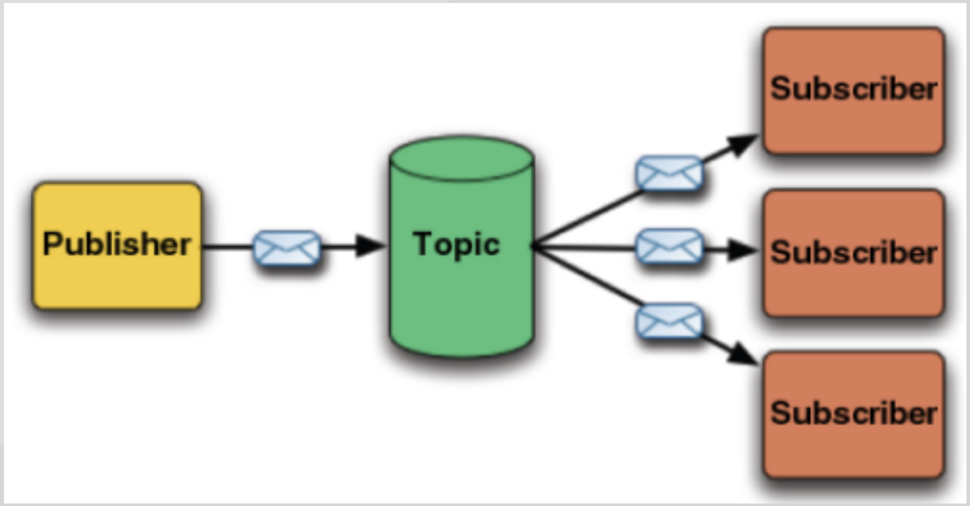
POINT TO POINT COMMUNICATION

- Destination is a queue
- one of multiple consumers gets message
- Load is distributed across consumers
- Message is stored until some consumers receives it



PUBLIS SUBSCRIBE DOMAIN

- Destination is a topic
- message is delivered to all subscribers
- message is thrown away if there is no subscription
- Durable subscriber
    - if durable subscriber disconnects broker is obliged to store all messages for later delivery



JMS API

- JMS 1.0 (2001)
  - Different APIs for pub/sub and PTP communication
- JMS 1.1 (2002)
  - Classic API - unified API for pub/sub and PTP
- JMS 2.0 (2013)
  - Classic API
    - it is not deprecated and will remain part of JMS indefinitely
  - Simplified API
    - less code needed
    - AutoCloseable resources -> Java 7 needed
    - no checked exceptions

CLASSES OF CLASSIC API

- ConnectionFactory - administered object
- Connection
- Session
- MessageProducer
- MessageConsumer
- Destination - administered object
- Message

DELIVERY MODE

- determines level of delivery reliability
  - Persistent (default)
    - provider should persist the message
    - message must be delivered once and only once even in case of provider failure
  - Nonpersistent
    - provider is instructed not ot presist the message
    - message must be delivered at most once
    - message is usually lost on provider failure
    - better performance

MESSAGE ACKNOWLEDGEMENT

- Delivery between broker and client is not considered successful until message is acknowledged.
- acknowledgement modes:
  - DUPS_OK_ACKNOWLEDGE
  - AUTO_ACKNOWLEDGE
  - CLIENT_ACKNOWLEDGE

TRANSACTIONS

- Session can be transacted
- multiple messages handled as atomic unit
- transaction is completed by calling commit() or rollback() on session
- commit also acknowledges message
- Support for distributed transaction is not required by JMS
  - but still many providers implement distributed transactions
  - JMS recommends support using JTA XAResource API

CODE EXAMPLES

- Classic API
  - synchronous send
  - asynchronous send
  - synchronous receive
  - asynchronous receive
- Simplified API

PART II

APACHE ACTIVEMQ

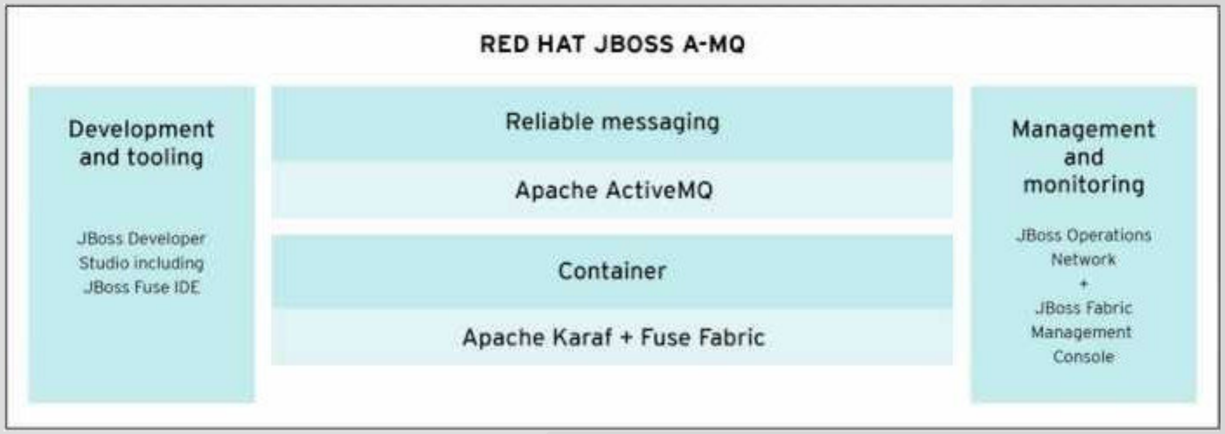
APACHE ACTIVEMQ

- Opensource MoM
- JMS 1.1 compliant
- Supports many protocols and clients
- other features:
  - High availability
  - scalibility
  - management
  - security

JBOSS A-MQ

- Open-source messaging platform
- Messaging system based on Apache ActiveMQ
- Runs on OSGI container
- Enable easy deployment
- Provides web based management console

JBOSS A-MQ



RED HAT JBOSS A-MQ
Development and tooling
JBoss Developer Studio including JBoss Fuse IDE
Reliable messaging
Apache ActiveMQ
Container
Apache Karaf + Fuse Fabric
Management and monitoring
JBoss Operations Network
+
JBoss Fabric Management Console

CONFIGURATION

- XML file
- most of things work out of the box

- Default configuration example

MESSAGE STORES

- kahaDB
- multi kahaDB
- levelDB
- JDBC

```
<persistenceAdapter>
    <kahaDB directory="${activemq.data}/kahadb"/>
</persistenceAdapter>
```

```
  <persistenceAdapter>
    <jdbcPersistenceAdapter dataSource="#derby-ds"/>
  </persistenceAdapter>


<!-- Embedded Derby DataSource Sample Setup -->
<bean id="derby-ds" class="org.apache.derby.jdbc.EmbeddedDataSource">
  <property name="databaseName" value="derbydb"/>
  <property name="createDatabase" value="create"/>
</bean>
```

CONNECTION TO BROKER

- Transport connectors
  - For client to broker connections
- Network connectors
  - For broker to broker connections
- Many transport protocols supported:
  - tcp, udp, nio, ssl, http/https, vm

WIRE PROTOCOLS

- Openwire
- STOMP
- AMQP
- MQTT

OPENWIRE

- Binary format developed for ActiveMQ purposes
- default wire format
- very efficient
- complex implementation
- Native clients for java, c/c++, c#
- advanced features:
  - flow control
  - client load balancing

STOMP

- Streaming text oriented message protocol
- very simple
- easy to implement
- worse performance

MQTT

- Client server publish/subscrbe messaging protocol
- ultra lightweight
- easy to implement
- supports only topics (no PTP messaging)

AMQP

- binary protocol
- open standard
- support both ptp and pub/sub
- advanced features:
    - flow control

TRANSPORT CONFIGURATION

- in transport connection section
- Connection type and options are defined by URI

```
<transportConnectors>
  <transportConnector name="mqtt"
        uri="mqtt://localhost:1883?wireFormat.maxFrameSize=100000"/>
  <transportConnector name="openwire"
        uri="tcp://0.0.0.0:61616?maximumConnections=1000&wireFormat.maxFrameSize=104857600"
        discoveryUri="multicast://default"/>
</transportConnectors>
```

HIGH LEVEL PROTOCOL URIS

- typically uses composite URI
- failover
- static

```
failover:(tcp://primary:61616,tcp://secondary:61616)?randomize=false
```

HIGH AVAILABILITY (HA)

- Messaging systems usually processes business critical data
- broker must be accessible 24/7
- ActiveMQ provides various mechanisms to ensure HA

HA IN ACTIVEMQ

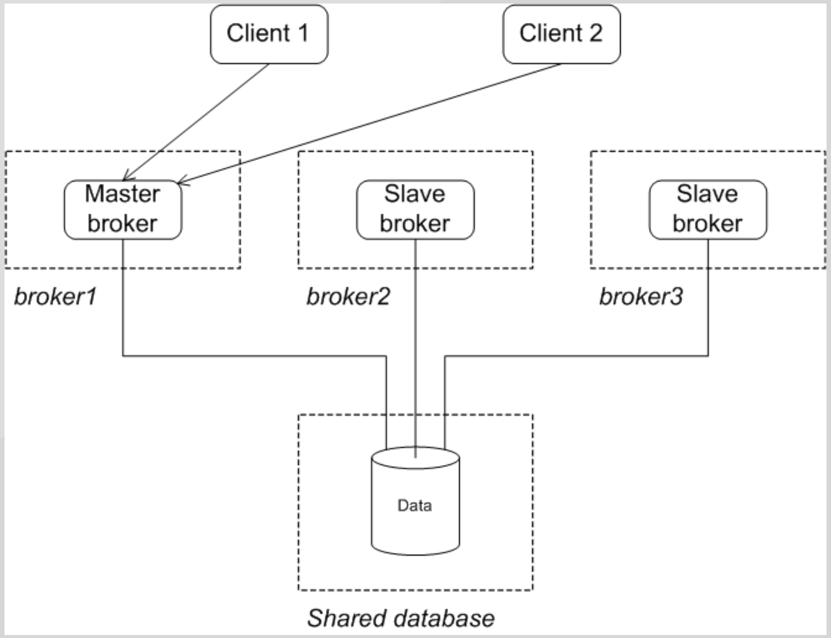
- Group of brokers forms logically one broker
- Master broker
  - communicates with clients
- Slave brokers
  - Passive (all connectors are stopped)
- election mechanisms
- client reconnects in case of failure (failover)
- Message acknowledgment after the message is stored safely

MASTER SLAVE FOR HA

- Shared JDBC master/slave
- Shared file system master/slave
- Replicated levelDB master/slave

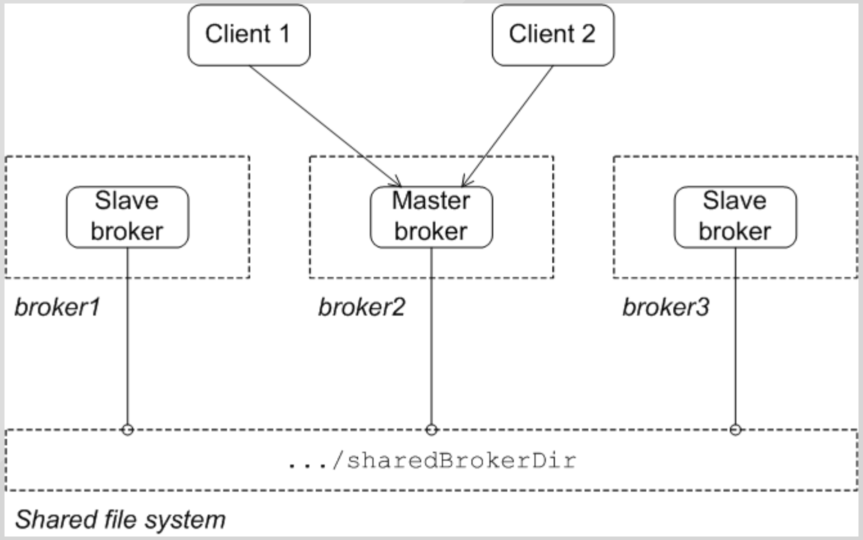
SHARED JDBC

- Shared database as persistence storage required
- Election mechanism: Locking tables in database
- Acknowledgment: After message is safely stored in database
- Single point of failure



SHARED FILESYSTEM

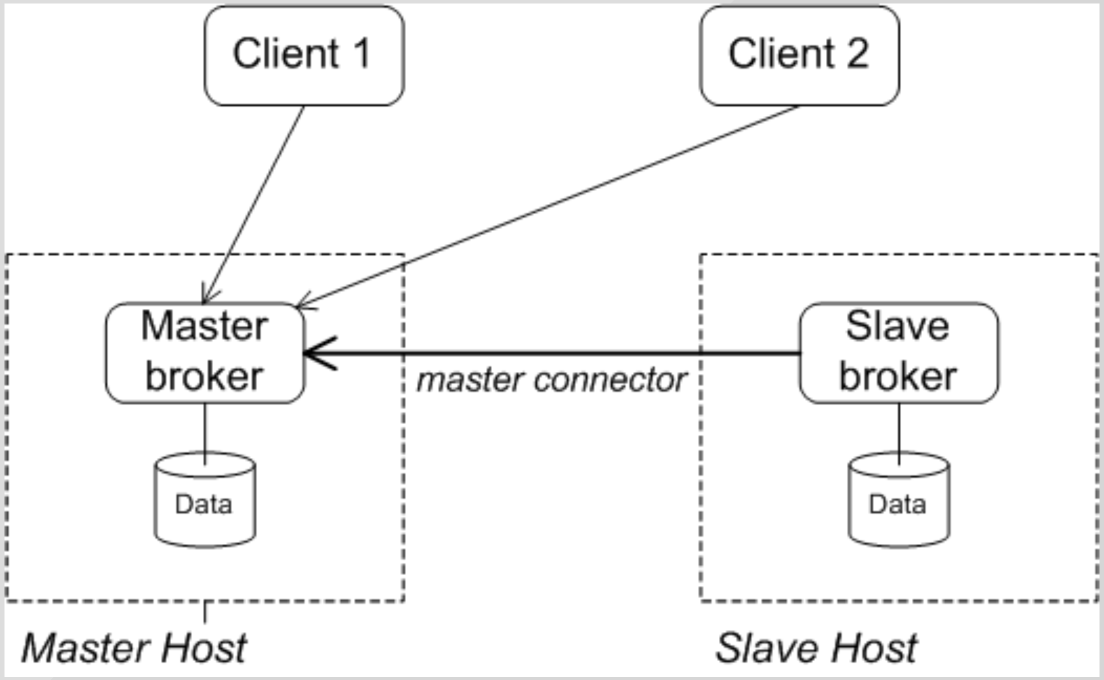
- Usually faster than JDBC
- Need file system with reliable locking mechanisms
- Persistent storage is located on shared file system
- Election mechanism: Locking file
- Acknowledgment: after message is stored on shared filesystem
- Single point of failure



REPLICATED LEVELDB

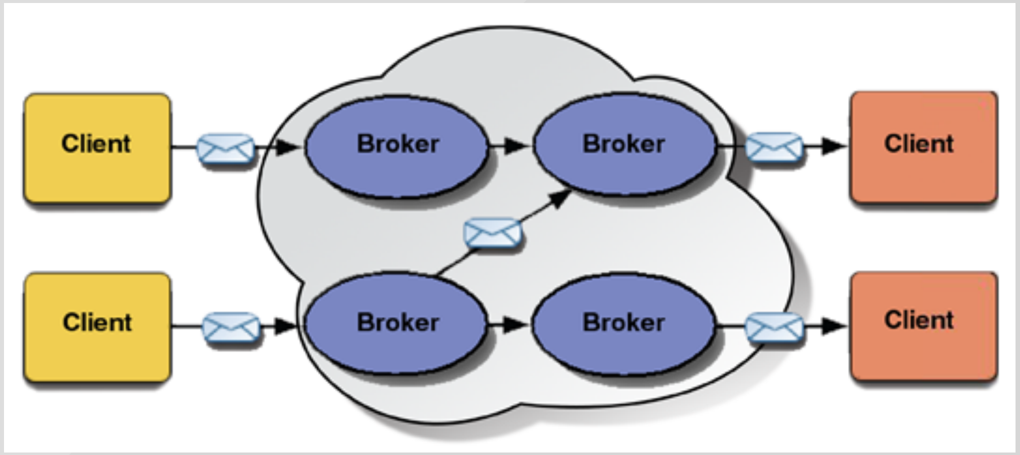
- Shared nothing
- No single point of failure
- Servers coordinates themselves by exchanging mess (replication protocol)
- Needs zookeeper server(s)
  - For master election only
- replication protocol
  - slave brokers connects to the master
  - message are replicated to slaves
  - message is acknowledged after replicating at least to quorum of brokers.

REPLICATED LEVELDB



NETWORK OF BROKERS

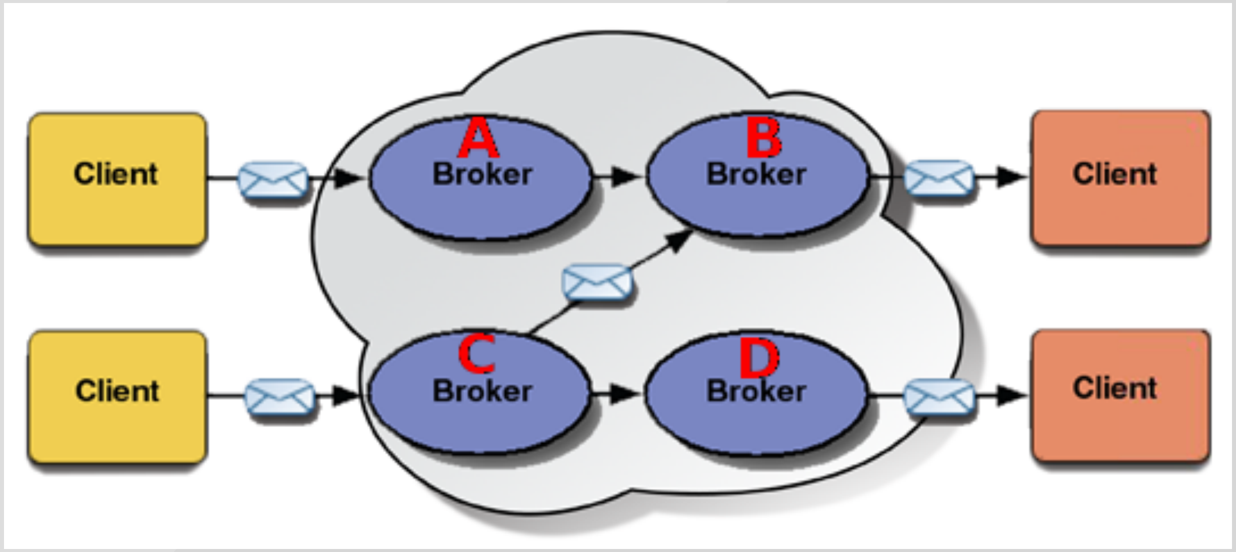
- connections between broker
- message forwarding
- enables massive scalability
- requires careful configuration



NETWORK CONNECTOR

Broker A :

```
<networkConnectors>
  <networkConnector uri="static:(tcp://B:61617)"/>
</networkConnectors>
```

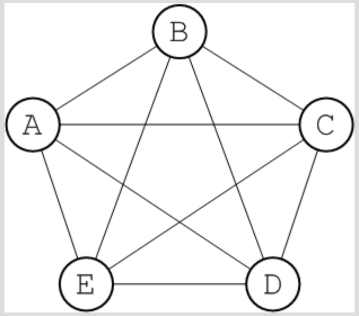


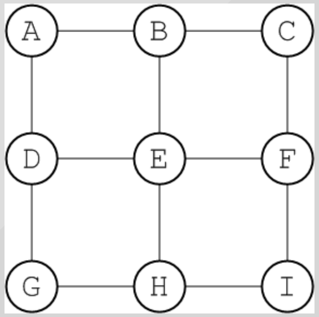
NETWORK OF BROKERS

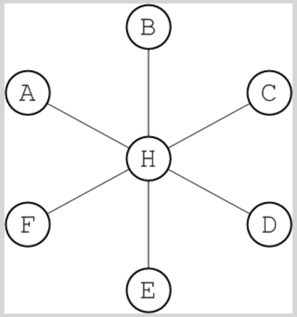
- duplex connections
- destination filtering
- dynamic vs static forwarding
- AdvisoryMessages
- network consumer priority
- networkTTL

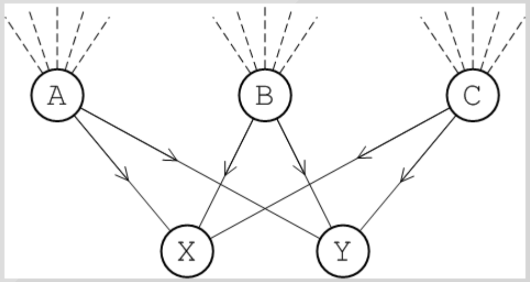
HIERARCHIES OF NETWORKS

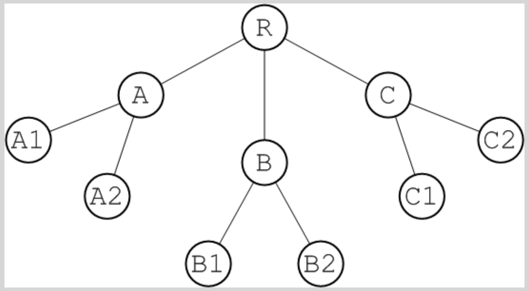
- concentrator topology
- hub and spokes topology
- tree topology
- mesh topology
- complete graph











OTHER ACTIVEMQ FEATURES

- exclusive consumers
- message groups
- wildcards (. * >)
- virtual topic
- DLQ

APACHE ACTIVEMQ ARTEMIS

- new Apache MoM
- non-blocking architecture => great performance
- merges codebase with JBoss HornetQ
- JMS 2.0 compliant
- Support for:
  - ActiveMQ clients
  - AMQP
  - STOMP
  - HornetQ clients

THANK YOU!