webMethods EntireX

High Availability

Version 10.5

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WEBMETHODS

This document applies to webMethods EntireX Version 10.5 and all subsequent releases.

Specifications contained herein are subject to change and these changes will be reported in subsequent release notes or new editions.

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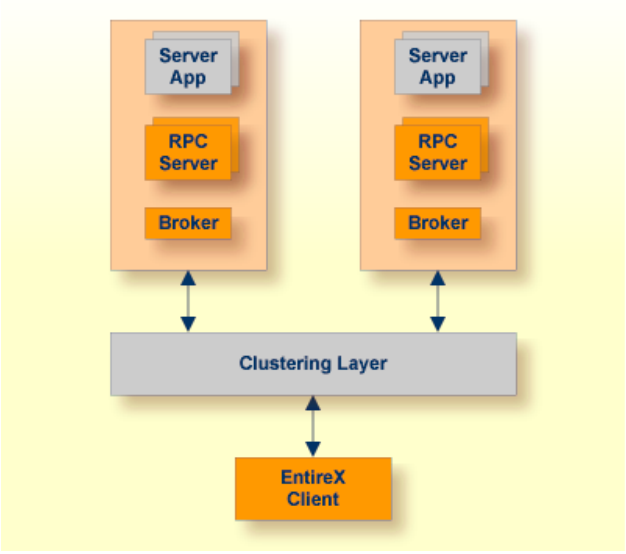
Table of Contents

High Availability in EntireX

Under High Availability we understand an environment with engineered redundancy which, if any one component fails, guarantees the integrity of the system as a whole. To achieve high availability, EntireX uses existing third-party clustering technology.

Eliminating Single Points of Failure

This is achieved by adding redundancy to the system, so that failure of a component does not mean failure of the entire system. Virtual IP addressing allows you to have several redundant systems to eliminate single points of failures that can be combined with external load balancing solution. In the picture below, you can imagine that there are several hosts, each host with one Broker, multiple RPC servers and server applications.



Reliable Crossover

Note: This solution applies to simple synchronous scenarios only; see *Client Considerations* for details and prerequisites.

If one Broker fails, goes down or the host goes down, the current call will fail but the client will notice that and resend the call. The call will then automatically routed to a different Broker and can be processed there.

Detecting Failures as they Occur

EntireX provides a variety of monitoring, logging and tracing facilities:

- Command Central offers live monitoring of EntireX Broker and RPC servers
- CIS (Command and Info Services) allows you to retrieve a wide range of live information from an EntireX Broker
- webMethods Optimize for Infrastructure can be used to monitor brokers and servers
- Logs at several different log levels allow detailed analysis

Platform-specific Considerations

The scenario you choose depends on the platform where your clustering environment is set up, typically the environment where your broker is running:

- *High Availability with Sysplex under z/OS*
- *High Availability with NLB under Windows*
- *High Availability with Other Clustering Technologies*
- *High Availability with Container Orchestration*

1 About this Documentation

Document Conventions

Convention	Description
Bold	Identifies elements on a screen.
`Monospace font`	Identifies service names and locations in the format *`folder.subfolder.service`*, APIs, Java classes, methods, properties.
`Italic`	Identifies: Variables for which you must supply values specific to your own situation or environment. New terms the first time they occur in the text. References to other documentation sources.
`Monospace font`	Identifies: Text you must type in. Messages displayed by the system. Program code.
{ }	Indicates a set of choices from which you must choose one. Type only the information inside the curly braces. Do not type the { } symbols.
|	Separates two mutually exclusive choices in a syntax line. Type one of these choices. Do not type the | symbol.
[ ]	Indicates one or more options. Type only the information inside the square brackets. Do not type the [ ] symbols.
...	Indicates that you can type multiple options of the same type. Type only the information. Do not type the ellipsis (...).

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2 Introduction to High Availability

Purpose of Clustering

When determining how to increase availability and to decrease downtime for important applications, there are many different clustering solutions to consider. It is important to start any availability improvement discussion however, with a preemptive understanding of what it is you want to improve. Begin by looking at the history of your application failures, downtime scenarios, and the underlying causes of availability issues. Map out your application topology and network infrastructure such that you can ascertain potential weak spots or single points of failure and prioritize component redundancy based on exposed risk to the overall system availability. Ask yourself the following questions:

- What is it that I want to accomplish from clustering?
- Who are the stakeholders?
- How will I measure availability improvement?

Once you have a prioritized list of availability improvement objectives, look for solutions that address these points of failure and look to provision an implementation plan that ensures a prearranged level of operational performance will be met during a contractual measurement period. Improvement must be measurable in both the technical and business perspectives.

Why is High Availability Important

Many of the world's largest organizations including financial institutions, manufacturing, transportation, and communication companies along with large government agencies, rely on the availability and reliability of applications to deliver their most important business transactions and data. These large-scale information systems consist of several hardware and software components, each of which performs a particular function and is a critical-path to successful daily operations. If any of these components fail however, the outcome could vary drastically - from a single user experiencing a slow-down in their order response time, to thousands of retail bank customers not being able to access any of their cash assets. Creating a highly available system topology removes any single points of failure from a large system, enabling another redundant component to effectively take over the workload of the failed component. Improving availability ultimately leads to a reduction in downtime, improved business performance, and a better user experience.

Another IT concern is how to apply maintenance and upgrades to these important systems without affecting users. In a highly available world, a system in need of maintenance can be taken out of the workload pool and updated while the rest of the system continues to process service requests.

Clustering for High Availability, Load Balancing and Fault Tolerance

As previously mentioned, there is a wide variety of clustering techniques that are designed to accomplish specific improvement in application availability based on planned or unplanned events. Planned events are typically scheduled maintenance activities associated with specific fixes or general upgrades. In this case, clustering can be utilized to maintain processing workloads while certain instances or services of the cluster are brought down, updated, and rejoined to the cluster.

Unplanned events require a means of automated failover whereby work is picked up by a pooled resource. Cluster architectures vary in how they handle fault tolerance, recovery, and guarantee delivery. Each high availability solution has a different architecture or technique in which work is redirected to or picked up by an available process. There are shared memory solutions (e.g. Terracotta Server Array), shared data store (e.g. Integration Server cluster), shared message queue (e.g. Universal Messaging), and shared virtual IP (e.g. EntireX Broker) among the list of possible solutions. Each technique provisions a group or cluster of common processes working on in-flight data or messages that may or may not be persisted and coordinated by the state of the application endpoints.

Advantages of Network-based Clustering

While a loosely coupled system such as network clustering cannot recover or coordinate distributed work, it does protect against a wide range of failures up and down the stack including hardware, OS, and application failures. Network-based HA solutions are relatively easy to configure and work transparently with stateless applications.

Another advantage is to address system availability during planned events such as applying maintenance patches or upgrades. For example, when a major or minor update is required to be performed to a broker, it is important that the system remains operational during this planned event. In this case, individual broker instances are taken out of the cluster without impacting the overall operation of the system. As updates are completed, Brokers can individually be added back into the cluster independent of their version.

Virtual IP Adressing

Traditionally, an IP address is associated with each end of a physical link (or each point of access to a shared-medium LAN), and the IP addresses are unique across the entire visible network, which can be the Internet or a closed intranet. The majority of IP hosts have a single point of attachment to the network, but some hosts (particularly large server hosts) have more than one link into the network.

A TCP/IP host with multiple points of attachment also has multiple IP addresses, one for each link. Within the IP routing network, failure of any intermediate link or adapter disrupts end user service only if there is not an alternate path through the routing network. Routers can route IP traffic around failures of intermediate links in such a way that the failures are not visible to the end applications or IP hosts. However, because an IP packet is routed based on ultimate destination IP address, if the adapter or link associated with the destination IP address fails, there is no way for the IP routing network to provide an alternate path to the stack and application.

Endpoint (source or destination) IP adapters and links thus constitute single points of failure. While this might be acceptable for a client host, where only a single user will be cut off from service, a server IP link might serve hundreds or thousands of clients, all of whose services would be disrupted by a failure of the server link.

The virtual IP address (VIPA) removes the adapter as a single point of failure by providing an IP address that is associated with a stack without associating it with a specific physical network attachment. Because the virtual device exists only in software, it is always active and never experiences a physical failure. A VIPA has no single physical network attachment associated with it.

Client Considerations

Only synchronous, non-conversational application scenarios are supported. Additional prerequisites apply to client applications:

- No Persistent Sockets (Socket Pooling)
- Socket Reconnect
- Security Handling

No Persistent Sockets (Socket Pooling)

Socket pooling needs to be explicitly disabled for all EntireX clients, except webMethods EntireX Adapter for Integration Server. See ***Matrix of Supported Features***.

Socket Reconnect

Client applications connected to a broker instance may need to react when this broker instance becomes unavailable and the cluster system establishes connection to a different broker instance.

Most EntireX clients support some reconnect logic on socket disconnect if the cluster system routes the connection to a different broker instance. However, the Java RPC and XML/SOAP client Java API do not support automatic reconnect. This needs to be handled by the client application logic.

Security Handling

If the Brokers in the cluster have security enabled, client applications need to re-authenticate with a new Broker instance on reconnect.

For Java RPC and XML/SOAP client Java API, re-authentication has to be completely handled by the client application.

Matrix of Supported Features

In the table below, “yes” means the feature is handled automatically and no user action or configuration is required; “application” means that the client application must be adapted accordingly.

Note: This table assumes you are using the latest version of the components listed.

RPC Client	No Persistent Sockets	Socket Reconnect	Security Handling
EntireX Adapter for IS	yes	yes	yes
RPC-ACI Bridge	Specify `socketpoolsize=0` as part of the broker ID. See *Socket Pooling Parameters for TCP and SSL/TLS Communication* under *Writing Advanced Applications - EntireX Java ACI*.	yes	yes
Listener for IBM MQ	Specify `socketpoolsize=0`.	yes	yes
SAP XI Adapter	Specify `socketpoolsize=0`.	yes	yes
Java RPC	Specify `socketpoolsize=0`.	application	application
XML/SOAP client API	Specify `socketpoolsize=0`.	application	application
Listener for XML/SOAP	Specify `socketpoolsize=0`.	yes	yes

RPC Client	No Persistent Sockets	Socket Reconnect	Security Handling
Natural RPC	Specify `ETB_SOCKETPOOL=OFF`. See *Support of Clustering in a High Availability Scenario* under *Administering Broker Stubs* in the platform-specific Administration documentation.	yes	application
C RPC	Specify `ETB_SOCKETPOOL=OFF`.	yes	application
COBOL RPC	Specify `ETB_SOCKETPOOL=OFF`.	yes	application
PL/I RPC	Specify `ETB_SOCKETPOOL=OFF`.	yes	application
.NET Wrapper	Specify `ETB_SOCKETPOOL=OFF`.	yes	application
DCOM Wrapper	Specify `ETB_SOCKETPOOL=OFF`.	yes	application

3 Commonly Used High Availability Terms

Clustering

Clustering is a technique to improve availability by configuring redundant resources such that if one instance fails it does not disrupt system availability to users.

DVIPA

Dynamic virtual IP address (DVIPA) is a z/OS Communications Server feature used to describe the automatic failover of TCP/IP stack instances within a Sysplex cluster.
See *Setting up your EntireX Environment for Sysplex*.

Failover

Feature used to describe the control switch between redundant resources in the event of a resource failure.

Fault Tolerance

Describes the process of delivering continuous operation in the event of an unplanned outage.

High Availability

Under High Availability we understand an environment with engineered redundancy which, if any one component fails, guarantees the integrity of the system as a whole. To achieve high availability, EntireX uses existing third-party clustering technology.

HiperSockets

HiperSockets is an IBM technology for offering TCP/IP communications between partitions at in-memory speed.

Load Balancing

A network-based technique to distribute common workload across multiple back-end services that can be evenly distributed or routed based on weighted inference of a key performance attribute (commonly called filtering).

LPAR

A logical partition (LPAR) describes the virtualization of the System z hardware platform; if one LPAR goes down it has no effect on any others running on the same hardware.

NLB

Network Load Balancing (NLB) is a clustering technology for Windows servers that enhances the scalability and availability of mission-critical, TCP/IP-based services, such as Web, Terminal Services, virtual private networking, and streaming media servers.
See *Setting up your EntireX Environment for NLB*

Node Convergence

The process of converging static machine addresses into a clustered IP address on Windows.

Queued Direct I/O (QDIO)

Queued Direct I/O (QDIO) is a System z hardware feature offering an enhanced data transfer architecture for improving data transfer speed and efficiency for TCP/IP traffic.

Sysplex

A Parallel Sysplex is a cluster of IBM mainframes acting together as a single system image with z/OS. Parallel Sysplex combines data sharing and parallel computing to allow a cluster of up to 32 systems to share a workload for high performance and high availability.
See *Setting up your EntireX Environment for Sysplex*

Transaction Recovery

A feature for recovering resources in the event of an unplanned outage.

VIPA

Virtual IP addressing is an IP address assigned to multiple static IP addresses to make them accessible as one address for the purpose of improving availability or load balancing.

WLM

IBM Workload Manager is a Sysplex based load balancer offering workload filtering.

24x7

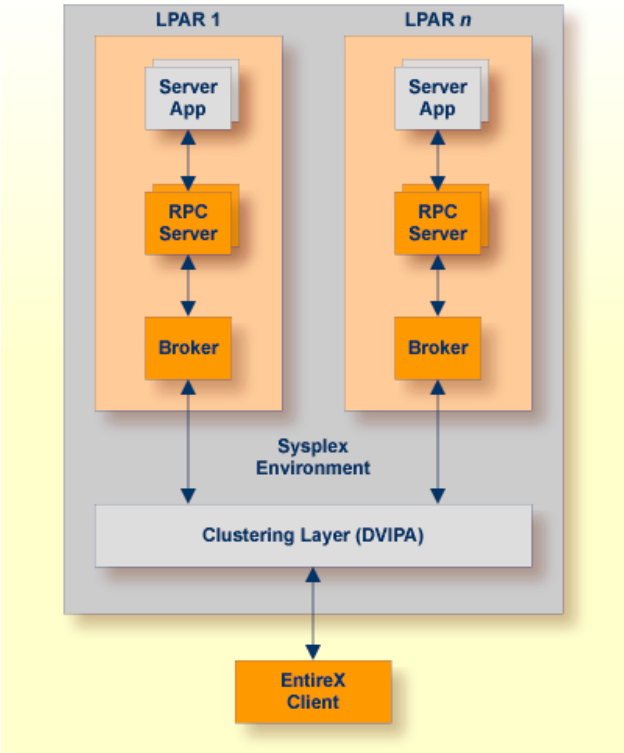
A business definition for highly available applications representing 24 hours, 7 days a week availability.

99.999

A business definition for highly available applications representing a percentage very close to 100% availability.

4 High Availability with Sysplex under z/OS

This graphic shows a cluster environment using IBM Sysplex technology to achieve high availability. Clustering is a technique to improve availability by configuring redundant resources - in the case of EntireX this means brokers and RPC servers. This redundancy ensures that if one instance fails the integrity of the system is not affected. Up to 32 logical partitions (LPARs) - often geographically distributed - can act together as a single system image. Dynamic virtual IP address (DVIPA) is a z/OS Communications Server feature used to describe the automatic failover of TCP/IP stack instances within a Sysplex cluster.

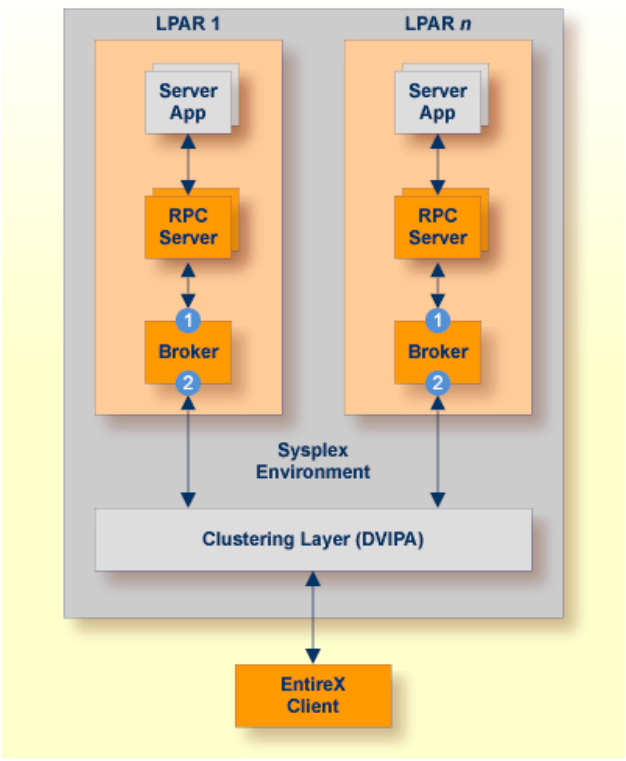


For more details, see *Setting up your EntireX Environment for Sysplex*.

5 Setting up your EntireX Environment for Sysplex

Scenario: “I want to use Sysplex for my high availability cluster.”

Setting Broker Attributes



Segmenting dynamic workload from static server and management topology is critically important. Using broker TCP/IP-specific attributes, define two separate connection points:

- One for RPC server-to-broker and admin connections. (1)
- The second for client workload connections. (2)

See *TCP/IP-specific Attributes*. Sample attribute file settings:

	Sample Attribute File Settings	Note
(1)	`PORT=1972`	In this example, the `HOST` is not defined, so the default setting will be used (localhost).

	Sample Attribute File Settings	Note
(2)	`HOST=10.20.74.103 (or DNS)` `PORT=1811`	In this example, the `HOST` stack is the virtual IP address. The `PORT` will be shared by other brokers in the cluster.

Broker Cluster Considerations

Platform-independent Considerations

We recommend the following:

- Share configurations - you will want to consolidate as many configuration parameters as possible in the attribute setting. Keep separate yet similar attribute files.
- Isolate workload listeners from management listeners.

z/OS-specific Considerations

- Use Started Task names that match EntireX Broker naming conventions and have logical context.
- z/OS supports multiple TCP/IP stacks per LPAR. EntireX Broker supports up to eight separate listeners on the same or different stacks.

Configuring Redundant RPC Servers

In addition to broker redundancy, you also need to configure your RPC servers for redundant operations. We recommend the following best practices when setting up your RPC servers:

- **General Hints**
  - Make sure your definitions for `CLASS/SERVER/SERVICE` are identical across the clustered brokers. Using identical service names will allow the broker to round-robin messages to each of the connected RPC server instances.
  - For troubleshooting purposes, and if your site allows this, you can optionally use a different user ID for each RPC server.
  - RPC servers are typically monitored using Command Central as services of a broker.
  - Establish the broker connection using the static `Broker name:port` definition.
- **RPC Server for CICS**
  - RPC Server for CICS instances can be configured through the *`ERXMAIN` Macro* that contains default settings and naming conventions. You can use the *RPC Online Maintenance Facility* to control and monitor these instances online.

- If you are using server-side mapping files, share the server-side mapping container across RPC server instances. A server-side mapping file is a Designer file with extension .svm. See *Server Mapping Files for COBOL*. Use VSAM RLS or simple share options to keep a single image of the server-side mapping container across all or groups of RPC servers (for example CICS, IMS, Batch). See *Job Replacement Parameters* under *Simplified z/OS Installation Method* in the z/OS Installation documentation.

- **RPC Server for Batch**
  - Make sure logging is distinguishable through each RPC Server instance for troubleshooting purposes (e.g. `JES SYSOUT`).
- **Natural RPC Server**
  - Maintain separate parameter files for each Natural RPC Server instance.

Verifying your Configuration

Here are some sample commands for verifying your cluster environment:

To display the Netstat Dynamic VIPA status

- Enter command

```
D TCPIP,TCPIPEXB,N,VIPADYN
```

Status must be `"ACTIVE"`.

```
EZZ2500I NETSTAT CS V1R13 TCPIPEXB 187
DYNAMIC VIPA:
  IP ADDRESS      ADDRESSMASK     STATUS    ORIGINATION     DISTSTAT
  10.20.74.103    255.255.255.0   ACTIVE    VIPADEFINE      DIST/DEST
    ACTTIME:      11/17/2011 09:29:13
```

To display the Netstat Dynamic VIPA info

- Enter command

```
D TCPIP,TCPIPEXB,N,VIPADCFG
```

This shows multiple static definitions to one dynamic definition:

```
EZZ2500I NETSTAT CS V1R13 TCPIPEXB 190
DYNAMIC VIPA INFORMATION:
  VIPA DEFINE:
    IP ADDRESS       ADDRESSMASK      MOVEABLE  SRVMGR FLG
    ----------       -----------      --------  ------ ---
    10.20.74.103     255.255.255.0    IMMEDIATE NO
  VIPA DISTRIBUTE:
    IP ADDRESS       PORT   XCF ADDRESS      SYSPT  TIMAFF  FLG
    ----------       ----   -----------      -----  ------  ---
    10.20.74.103     18000  10.20.74.104     NO     NO
    10.20.74.103     18000  10.20.74.114     NO     NO
```

To display Sysplex VIPA Dynamic configuration

- Enter command

```
D TCPIP,TCPIPEXB,SYS,VIPAD
```

This verifies that multiple LPARs have been defined (`MVSNAME`s):

```
EZZ8260I SYSPLEX CS V1R13 166
VIPA DYNAMIC DISPLAY FROM TCPIPEXB AT AHST
IPADDR: 10.20.74.103  LINKNAME: VIPL0A144A67
  ORIGIN: VIPADEFINE
  TCPNAME  MVSNAME  STATUS RANK ADDRESS MASK    NETWORK PREFIX
  -------- -------- ------ ---- --------------- --------------
  TCPIPEXB AHST     ACTIVE      255.255.255.0   10.20.74.0
  TCPIPEXB BHST     BACKUP 001
```

Managing Brokers and RPC Servers

Lifecycle Management of Brokers

An important aspect of high availability is during planned maintenance events such as lifecycle management, applying software fixes, or modifying the number of runtime instances in the cluster. Using a virtual IP networking approach for broker clustering allows high availability to the overall working system while applying these tasks.

See *Starting and Stopping the Broker* in the z/OS Administration documentation.

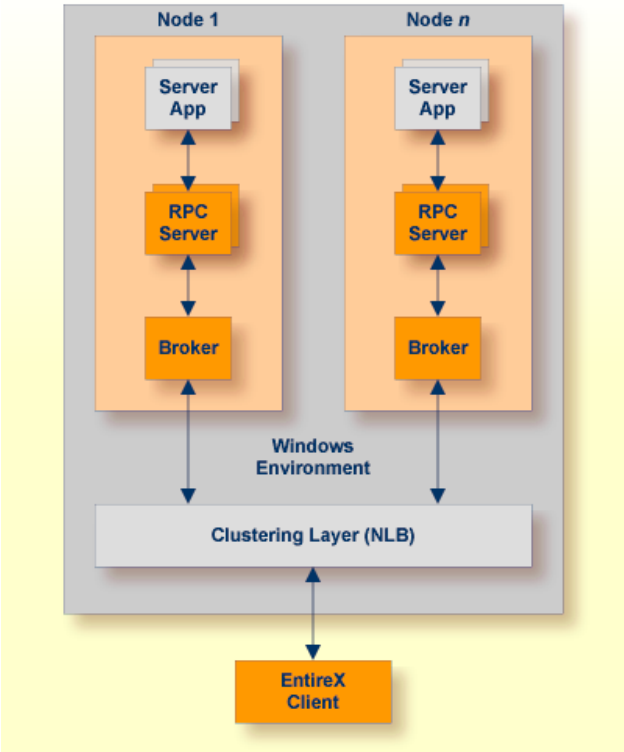
You can ping and stop a broker using the command-line utility `ETBCMD`.

Lifecycle Management of RPC Servers

Starting, pinging and stopping an RPC server is described in the EntireX documentation for CICS | Batch | IMS RPC servers.

See also *Operating a Natural RPC Environment* in the Natural documentation.

6 High Availability with NLB under Windows



The Network Load Balancing (NLB) feature in Windows Server enhances the availability and scalability of EntireX Broker and other mission-critical applications. NLB is intended for atomic applications that do not have long-running-in-memory or conversational states. Essentially, each client call to a stateless application is a separate transaction, so it is possible to distribute the requests among multiple servers to share the work load. One attractive feature of NLB is that all servers in a cluster monitor each other with a heartbeat signal, so there is no single point of failure.

In theory, a single broker instance running on Windows Server provides a limited level of server reliability and scalable performance. However, by combining the resources of two or more Brokers

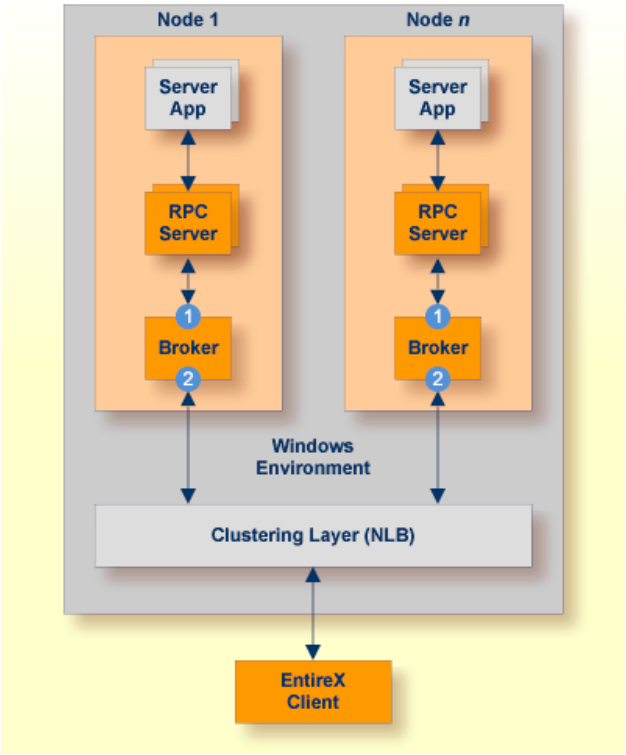
into a single virtual cluster, NLB can deliver the reliability and performance that mission-critical servers such as EntireX need.

See ***Setting up your EntireX Environment for NLB*** for more details.

7 Setting up your EntireX Environment for NLB

Scenario: “I want to use Windows NLB for my high availability cluster.”

Setting Broker Attributes



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- One for RPC server-to-broker and admin connections. (1)
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See *TCP/IP-specific Attributes*. Sample attribute file settings:

	Sample Attribute File Settings	Note
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Broker Cluster Considerations

Platform-independent Considerations

We recommend the following:

- Share configurations - you will want to consolidate as many configuration parameters as possible in the attribute setting. Keep separate yet similar attribute files.
- Isolate workload listeners from management listeners.

Windows-specific Considerations

- The network load balancing service for all the machines should have the correct local time. Ensure the Windows Time Service is properly configured on all hosts to keep clocks synchronized. Unsynchronized times will cause a network login screen to pop up which doesn't accept valid login credentials.
- You have to manually add each load balancing server individually to the load balancing cluster after you've created a cluster host.
- To allow communication between servers in the same NLB cluster, each server requires the following registry entry: a DWORD key named "UnicastInterHostCommSupport" and set to 1, for each network interface card's GUID (HKEY_LOCAL_MACHINE\System\CurrentControl-Set\Services\WLBS\Parameters\Interface{GUID})
- NLB may conflict with some network routers, which are not able to resolve the IP address of the server and must be configured with a static ARP entry.
- Monitor brokers through Command Central.

Configuring Redundant RPC Servers

In addition to broker redundancy, you also need to configure your RPC servers for redundant operations. We recommend the following best practices when setting up your RPC servers:

- **General Hints**
  - Make sure your definitions for `CLASS/SERVER/SERVICE` are identical across the clustered brokers. Using identical service names will allow the broker to round-robin messages to each of the connected RPC server instances.
  - For troubleshooting purposes, and if your site allows this, you can optionally use a different user ID for each RPC server.
  - RPC servers are typically monitored using Command Central as services of a broker.
  - Establish the broker connection using the static `Broker name:port` definition.
- **Natural RPC Server**
  - Maintain separate parameter files for each Natural RPC Server instance.

Managing Brokers and RPC Servers

Lifecycle Management of Brokers

An important aspect of high availability is during planned maintenance events such as lifecycle management, applying software fixes, or modifying the number of runtime instances in the cluster. Using a virtual IP networking approach for broker clustering allows high availability to the overall working system while applying these tasks.

Broker administrators, notably on UNIX and Windows systems, have the need to start, ping (for Broker alive check) and stop Broker as well as RPC servers from a system command-line, prompt or from within batch or shell scripts. To control and manage the lifecycle of brokers, the following commands are available with Command Central:

- `sagcc exec lifecycle start local EntireXCore-EntireX-Broker-<broker-id>`
- `sagcc get monitoring state local EntireXCore-EntireX-Broker-<broker-id>`
- `sagcc exec lifecycle stop local EntireXCore-EntireX-Broker-<broker-id>`
- `sagcc exec lifecycle restart local EntireXCore-EntireX-Broker-<broker-id>`

Lifecycle Management of RPC Servers

To start an RPC server

- See *Starting the RPC Server*in the documentation of the respective RPC server.

To ping an RPC server

- Use the following Information Service command:

```
etbinfo -b <broker-id> -d SERVICE -c <class> -n <server name> -s <service> ↩
--pingrpc
```

To stop an RPC server

- See *Stopping the RPC Server*in the documentation of the respective RPC server.

  You can also use the command-line utility `etbcmd`. Example:

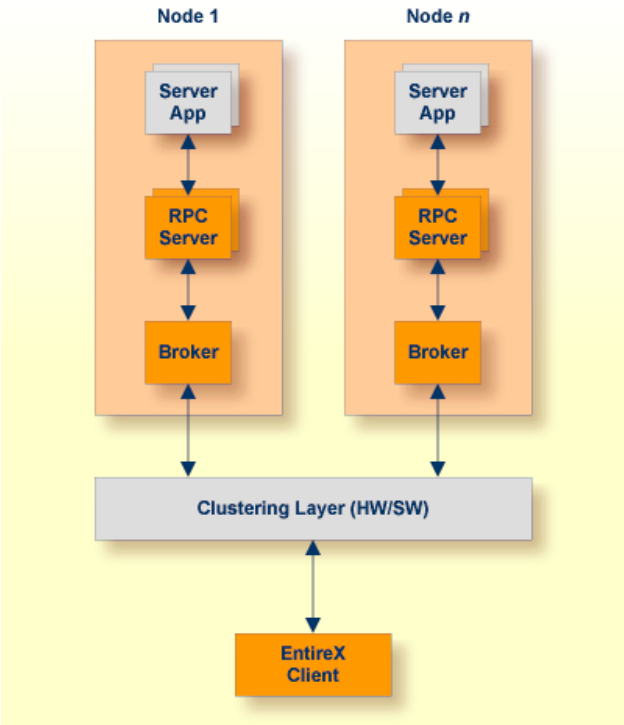
```
etbcmd -b <broker-id> -d SERVICE -o IMMED -m <class/server/service>
```

Restrictions

- All hosts in the NLB cluster must reside on the same subnet and the cluster's clients are able to access this subnet.
- When using NLB in multicast or unicast mode, routers need to accept proxy ARP responses (IP-to-network address mappings that are received with a different network source address in the Ethernet frame).
- Make sure the Internet control message protocol (ICMP) to the cluster is not blocked by a router or firewall.
- Cluster hosts and the virtual cluster IP need to have dedicated (static) IP addresses. This means you must request static IPs from your Network Services group.
- NLB clustering is a stateless failover environment that does not provide application or in-flight message recovery.
- Only TCP/IP is configured on the network interface that the NLB is configured for.

8 High Availability with Other Clustering Technologies

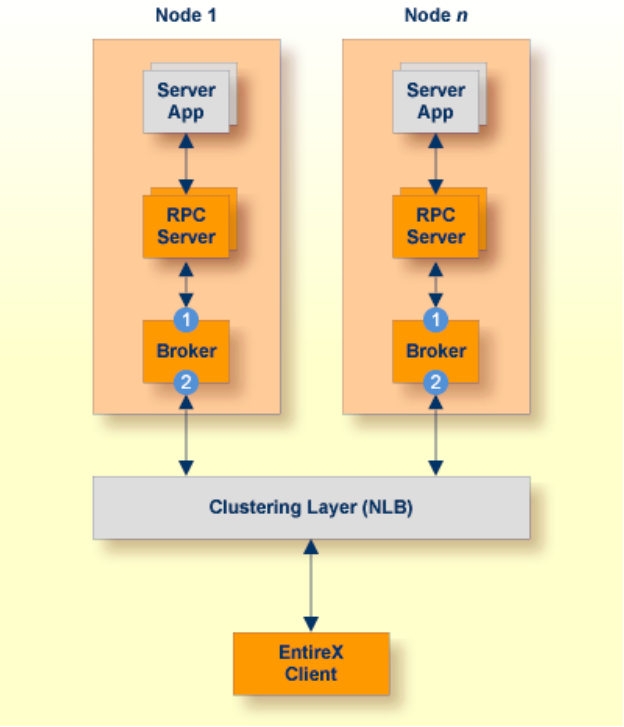
EntireX Brokers can also be clustered for the purpose of enhancing application availability and scalability with other IP-based load balancing solutions. From an EntireX Broker point of view, there is no fundamental difference between a HW or a SW clustering solution. It is up to the customer and their networking organization to reconcile the requirements of the EntireX project with what any particular technology can or cannot deliver. The following information represents the generic configuration of EntireX components using a network IP virtualization or clustering solution.



See also *Setting up Your EntireX Environment for High Availability with Other Clustering Technologies* for more details.

9 Setting up Your EntireX Environment for High Availability with Other Clustering Technologies

Setting Broker Attributes



Segmenting dynamic workload from static server and management topology is critically important. Using broker TCP/IP-specific attributes, define two separate connection points:

- One for RPC server-to-broker and admin connections. (1)
- The second for client workload connections. (2)

See *TCP/IP-specific Attributes*. Sample attribute file settings:

	Sample Attribute File Settings	Note
(1)	`PORT=1972`	In this example, the `HOST` is not defined, so the default setting will be used (localhost).
(2)	`HOST=10.20.74.103 (or DNS)` `PORT=1811`	In this example, the `HOST` stack is the virtual IP address. The `PORT` will be shared by other brokers in the cluster.

Broker Cluster Considerations

We recommend the following:

- Share configurations - you will want to consolidate as many configuration parameters as possible in the attribute setting. Keep separate yet similar attribute files.
- Isolate workload listeners from management listeners.

Configuring Redundant RPC Servers

In addition to broker redundancy, you also need to configure your RPC servers for redundant operations. We recommend the following best practices when setting up your RPC servers:

- **General Hints**
  - Make sure your definitions for `CLASS/SERVER/SERVICE` are identical across the clustered brokers. Using identical service names will allow the broker to round-robin messages to each of the connected RPC server instances.
  - For troubleshooting purposes, and if your site allows this, you can optionally use a different user ID for each RPC server.
  - RPC servers are typically monitored using Command Central as services of a broker.
  - Establish the broker connection using the static `Broker name:port` definition.
- **Natural RPC Server**
  - Maintain separate parameter files for each Natural RPC Server instance.
- Monitor brokers through Command Central.

Managing Brokers and RPC Servers

- Lifecycle Management of Brokers

Lifecycle Management of Brokers

An important aspect of high availability is during planned maintenance events such as lifecycle management, applying software fixes, or modifying the number of runtime instances in the cluster. Using a virtual IP networking approach for broker clustering allows high availability to the overall working system while applying these tasks.

Broker administrators, notably on UNIX and Windows systems, have the need to start, ping (for Broker alive check) and stop Broker as well as RPC servers from a system command-line, prompt or from within batch or shell scripts. To control and manage the lifecycle of brokers, the following commands are available with Command Central:

- `sagcc exec lifecycle start local EntireXCore-EntireX-Broker-<broker-id>`
- `sagcc get monitoring state local EntireXCore-EntireX-Broker-<broker-id>`
- `sagcc exec lifecycle stop local EntireXCore-EntireX-Broker-<broker-id>`
- `sagcc exec lifecycle restart local EntireXCore-EntireX-Broker-<broker-id>`

Lifecycle Management of RPC Servers

To start an RPC server

- See *Starting the RPC Server*in the documentation of the respective RPC server.

To ping an RPC server

- Use the following Information Service command:

```
etbinfo -b <broker-id> -d SERVICE -c <class> -n <server name> -s <service> ↩
--pingrpc
```

To stop an RPC server

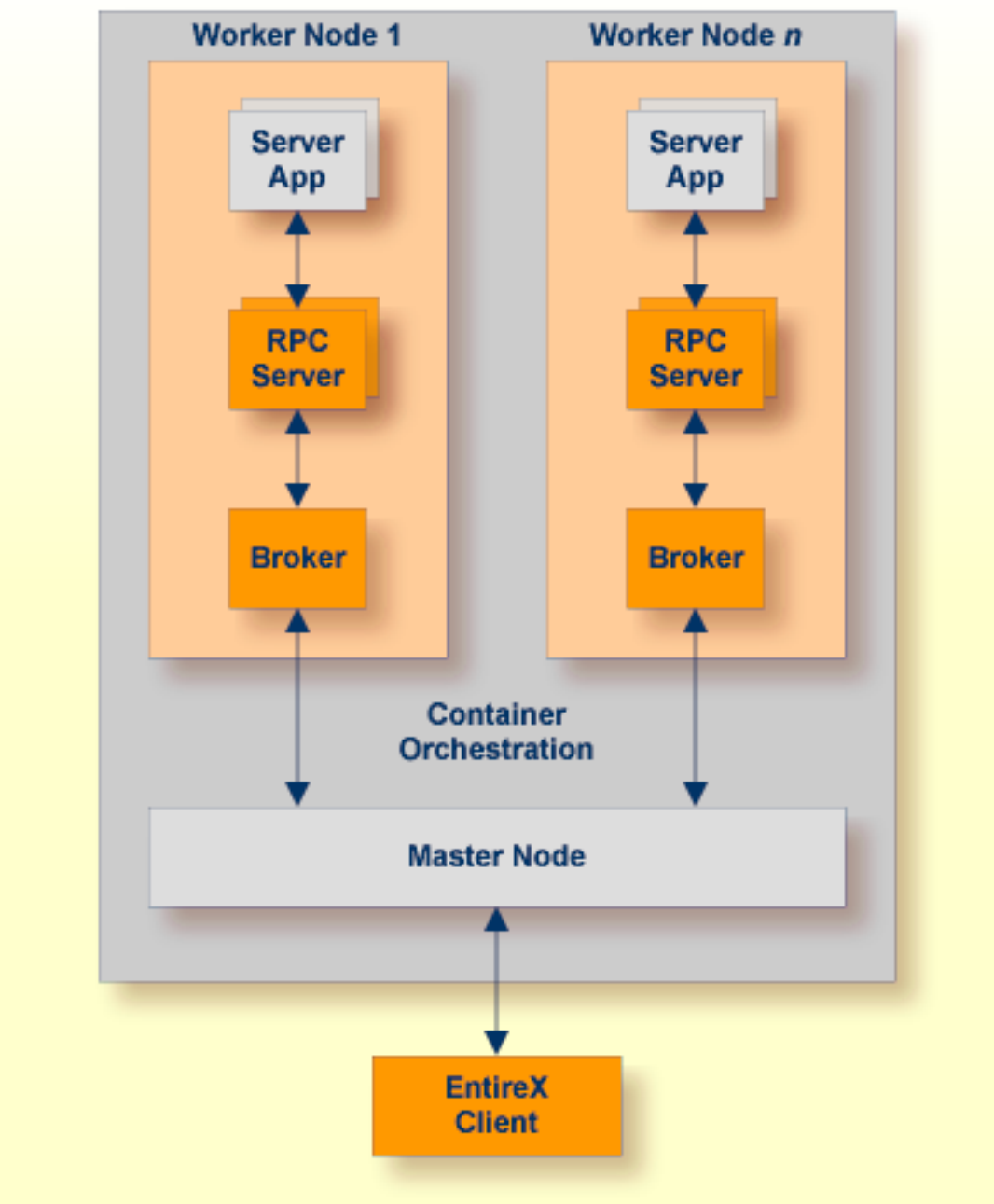
- See *Stopping the RPC Server*in the documentation of the respective RPC server.

  You can also use the command-line utility `etbcmd`. Example:

```
etbcmd -b <broker-id> -d SERVICE -o IMMED -m <class/server/service>
```

10 High Availability with Container Orchestration

Container Orchestration allows automated deployment, scaling and management of EntireX Brokers and EntireX RPC Servers running in Docker containers. Multiple instances of containers can be deployed on multiple nodes running on multiple hosts. Container orchestration allows load balancing and health monitoring. It supports takeover scenarios if, for example, one node or one container dies. The management of the worker nodes is done by the master node.



See also *Setting up your Environment for High Availability with Container Orchestration* for more details.

11 Setting up your Environment for High Availability with Container Orchestration

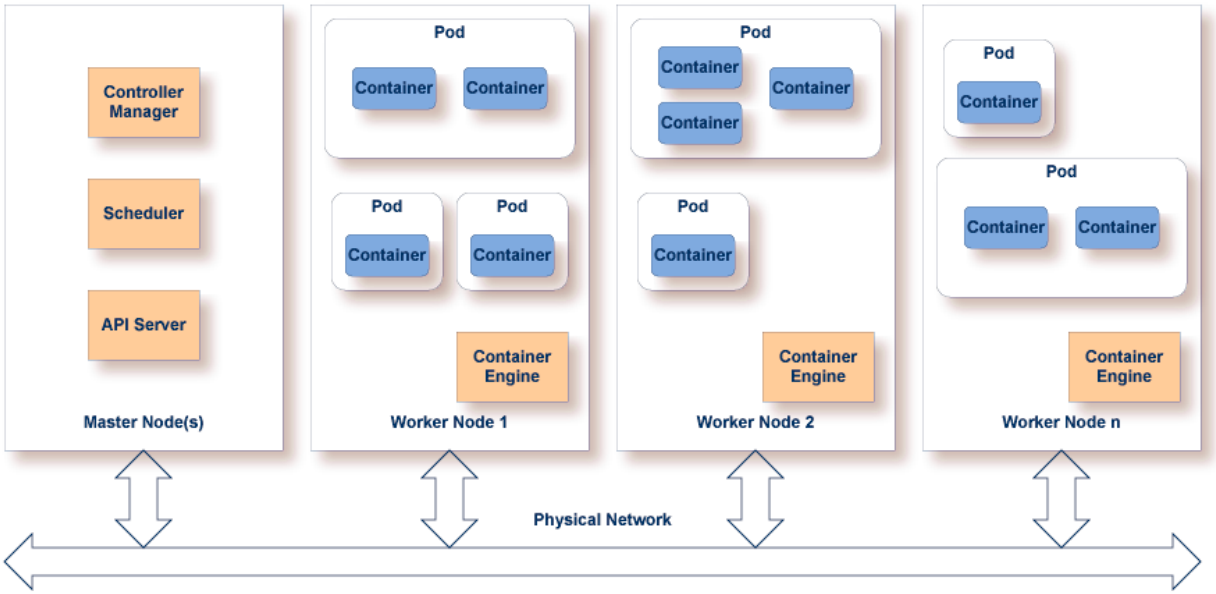
The following EntireX components are available as containers:

- EntireX Broker
- RPC Server for Java
- RPC Server for XML/SOAP

These containers can be deployed in a container orchestration environment, for example Kubernetes.

Container Orchestration Architecture

A typical container orchestration environment has at least one master node and several worker nodes. Containers can be deployed on multiple worker nodes. If one node fails, the remaining nodes keep the application alive. The deployable unit for a worker node is called a *pod*. A pod consists of at least one container. Containers running in the same pod share the same network namespace (same IP and port space) and the same IPC namespace (visible to each other over PID). From outside the pod, containers are only reachable via sockets.



Sample Deployment

This example assumes you have a Kubernetes cluster installed.

To Deploy EntireX Broker, RPC Server for Java, and RPC Server for XML/SOAP in a Kubernetes cluster

1 Create a pod containing the images of EntireX Broker, RPC Server for Java, and RPC Server for XML/SOAP.

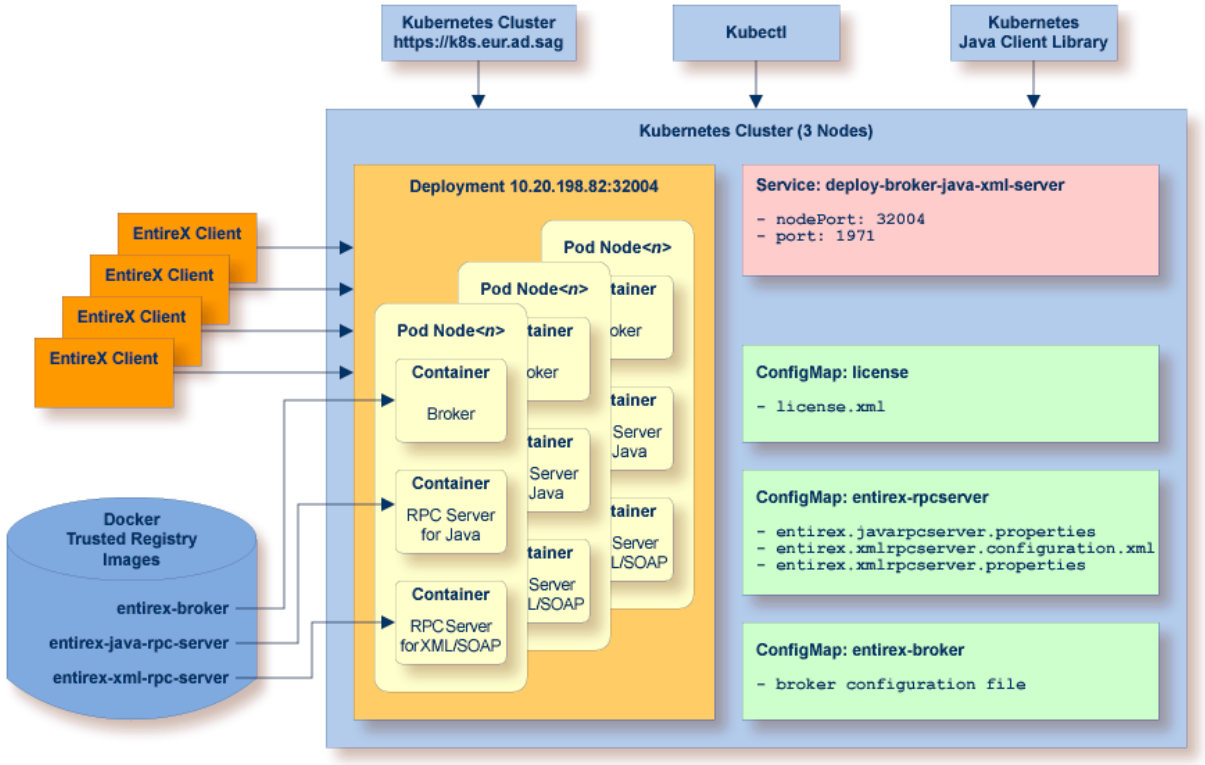
> **Note:** It makes sense to combine EntireX Broker and RPC servers for Java and XML/SOAP in one pod.

2 Configure a deployment for multiple broker and RPC server instances.

3 Assign a port to a service to access the broker and RPC servers from outside the Kubernetes cluster.

4 Use a ConfigMap to deploy the configuration files of your broker and RPC servers.

The following graphic shows the deployment of EntireX Broker, RPC Server for Java and RPC Server for XML/SOAP in a Kubernetes cluster:



Sample Configuration File

Kubernetes uses YAML files to describe the deployment of pods, services and ConfigMaps. Below is a sample configuration file *brokerRPCServer.yaml*:

The sample file describes a deployment with four pods (replicas). Each pod contains three containers:

- EntireX Broker
- RPC Server for Java
- RPC Server for XML/SOAP

With Kubernetes you can perform a healthcheck and a readiness check. The Kubernetes documentation uses the terms “liveness probe” and “readiness probe”. The difference between the two probes is as follows:

- When a *liveness* probe fails, the related pod is deleted and a new one is started.
- When a *readiness* probe fails, the related pod is marked as “unready”. This means that no messages will be sent to the related pod from the Kubernetes dispatcher.

Both the liveness and the readiness probe offer three kinds of checks:

- TCP check on a specified port
- HTTP check on a specified URL
- user-defined function with return value true (healthy) or false (unhealthy)

In this example, a TCP check on administration port could be used as a readiness probe for the RPC Server for Java. The readiness probe can be defined in the YAML file of the pod deployment.

Example for the RPC Server for Java:

```
readinessProbe:
      failureThreshold: 3
      initialDelaySeconds: 5
      periodSeconds: 10
      successThreshold: 1
      tcpSocket:
        port: 7001
      timeoutSeconds: 1.
```

Probes have a number of fields that you can use to control more precisely the behavior of liveness and readiness checks:

Field	Default	Description
`initialDelaySeconds`	0	Number of seconds after the container has started before a liveness or readiness probe is initiated.
`periodSeconds`	10	How often (in seconds) to perform the probe. Minimum value is 1.
`timeoutSeconds`	1	Number of seconds after which the probe times out. Minimum value is 1.
`successThreshold`	1	Minimum consecutive successes for the probe to be considered successful after having failed. Must be 1 for liveness. Minimum value is 1.
`failureThreshold`	3	When a pod starts and the probe fails, Kubernetes will try `failureThreshold` times before giving up. ■ For a *liveness* probe, giving up means restarting the container. ■ For a *readiness* probe, the pod will be marked "Unready". Minimum value is 1.

For the RPC Server for Java a readiness check is defined (readiness probe). The Kubernetes system checks the availability of the TCP port of the server (`tcpSocket:port`). This port must be defined as Administration Port defined in the properties file of the RPC Server for Java (`entire.javarpcserver.properties` > `entirex.server.monitorport`).

```
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  name: brokerandrpcserverdeployment
  labels:
    purpose: demonstrate-broker-and.jrpcserver-deployment
spec:
  selector:
    matchLabels:
      app: entirex
  replicas: 4
  template:
    metadata:
      labels:
        app: entirex
    spec:
      containers:
      - name: exxjavarpcserver-node-container
        image: repository.eur.ad.sag:4443/entirex/entirex-java-rpc
        readinessProbe:
         failureThreshold: 3
         initialDelaySeconds: 5
         periodSeconds: 10
         successThreshold: 1
         tcpSocket:
           port: 7001
```

```
        timeoutSeconds: 1
      env:
      - name: ACCEPT_EULA
        value: "Y"
      volumeMounts:
      - mountPath: /licenses
        name: config
      - mountPath: /data
        name: data1

  - name: exxxmlrpcserver-node-container
    image: repository.eur.ad.sag:4443/entirex/entirex-xml-rpc
    env:
    - name: ACCEPT_EULA
      value: "Y"
    volumeMounts:
    - mountPath: /licenses
      name: config
    - mountPath: /data2
      name: data2

  - name: exxbroker-container
    image:  repository.eur.ad.sag:4443/entirex/entirex-broker
    env:
    - name: ACCEPT_EULA
      value: "Y"
    volumeMounts:
    - mountPath: /licenses
      name: config
  volumes:
  - name: config
    configMap:
      name: exx-configmap1
  - name: data1
    configMap:
      name: exx-configmap2
  - name: data2
    configMap:
      name: exx-configmap3
```