

Management and Monitoring of a J2EE Server and Applications Using JMX

Reinhold Kautzleben, Gregor Frey
Speaker Title, SAP AG

How much JMX is required to be in J2EE?

JMX 1.2 belongs to the list of required APIs that a J2EE 1.4 compliant server has to provision. But there are some restrictions:

„The only JMX support required is specified in the J2EE Management specification.“ (J2EE 6.17)

So what JMX support does the J2EE Management specification require?

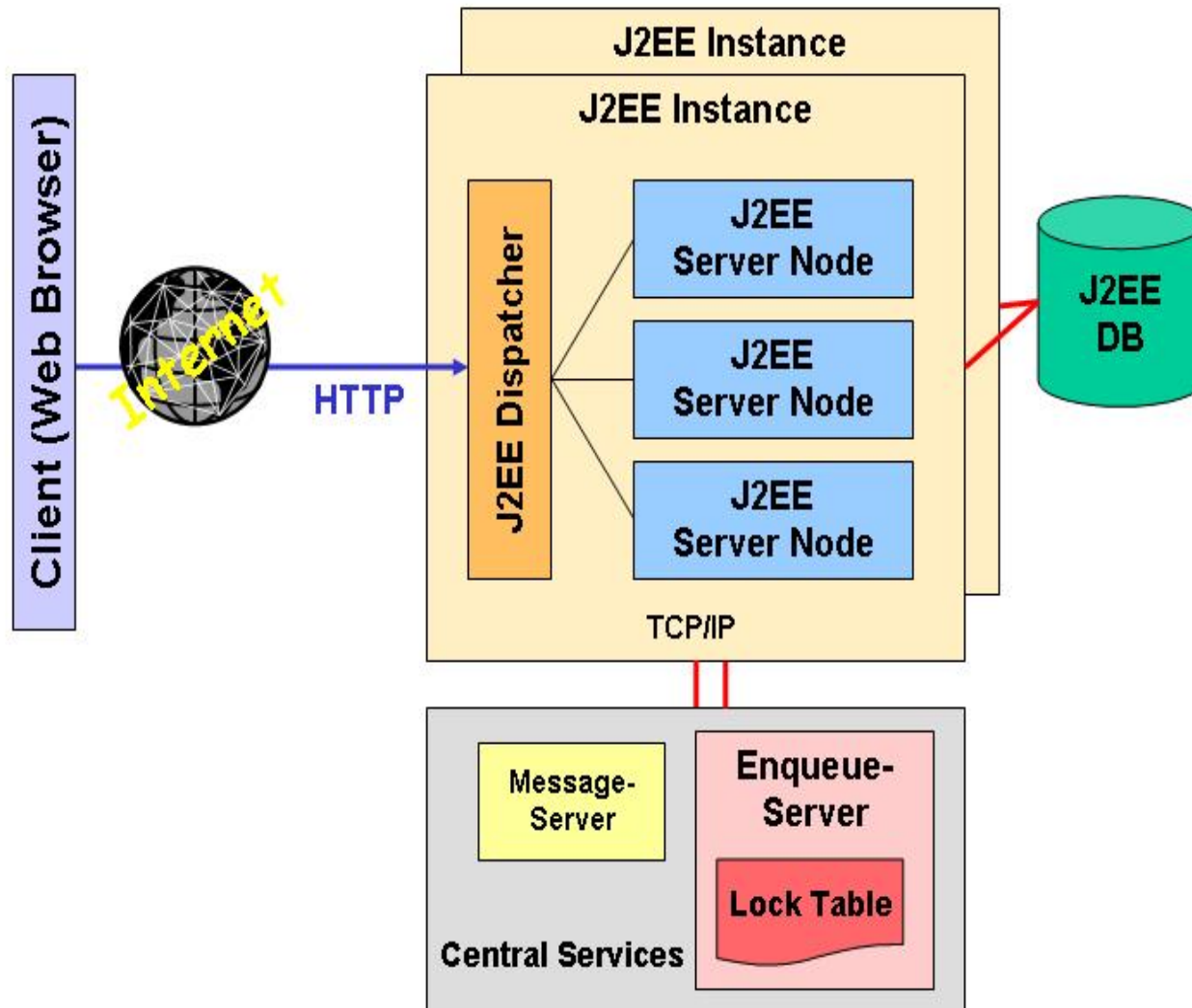
„The MEJB component exposes the manageable resources on a J2EE platform as JMX Managed Beans (MBeans) and requires an implementation of the JMX public APIs specified by the Java Management Extensions Instrumentation and Agent Specification, v1.1.“

This leaves room for interpretation 😊

Management and Monitoring of a J2EE Server Using JMX

Discussed using the Example of the SAP WebAS

Cluster Architecture of SAP J2EE



To reach a better scalability the SAP J2EEEngine contains a cluster of J2EE server processes

In every server process there is exactly one MBeanServer running

All MBeans register with the local MBeanServer (and only with this)

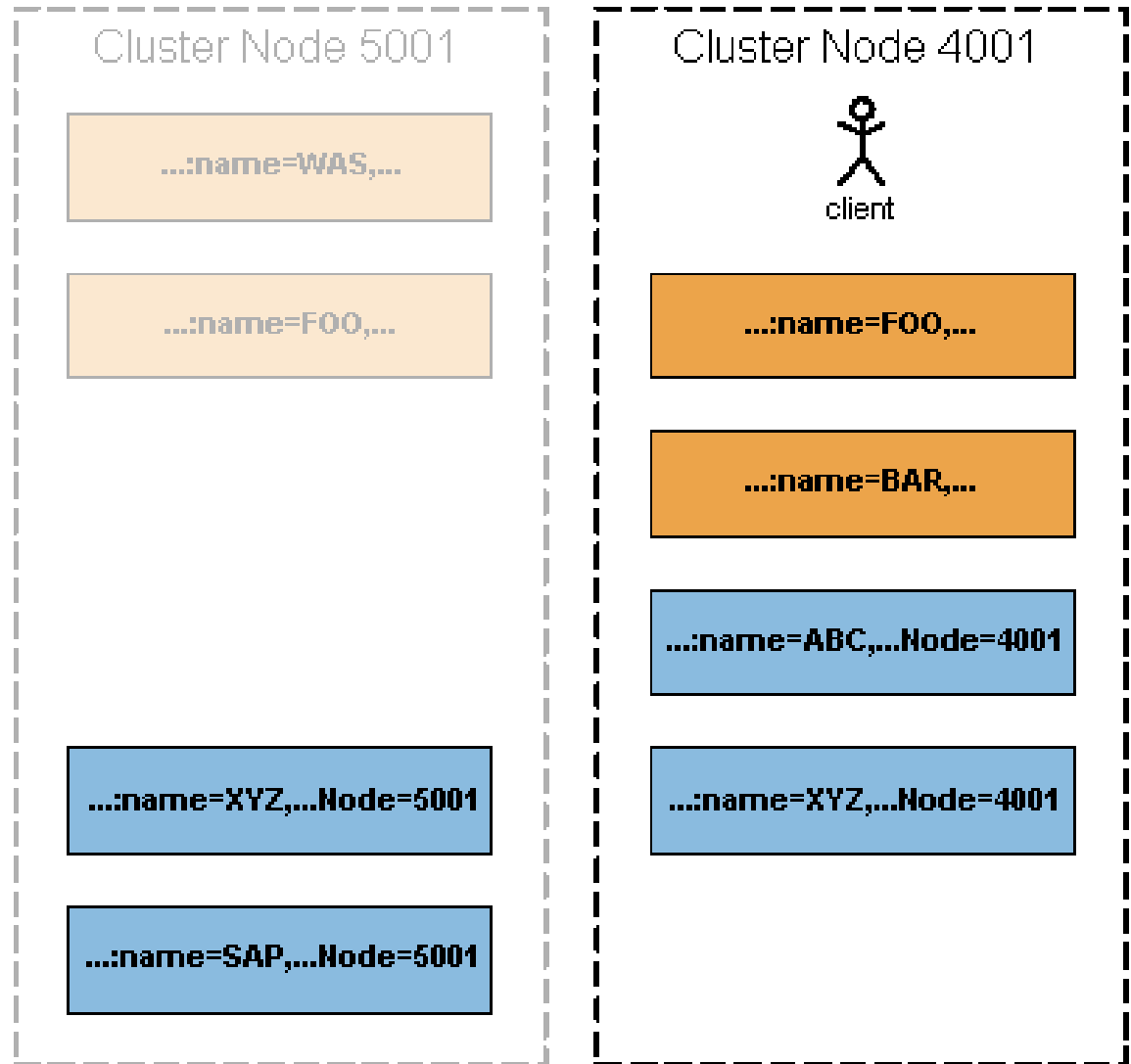
Problem: Management Clients connect to one and only one MBeanServer – How can they access MBeans in other cluster-nodes?

Visibility of MBeans

A client connected to a certain MBeanServer sees

■ All MBeans registered with the „local“ MBeanServer

■ All MBeans, which can be uniquely identified across the cluster



Local MBeans:

- Are used to manage node specific resources
- Should be visible regardless on which node a client is attached
- Are identified by an ObjectName, which is clusterwide unique

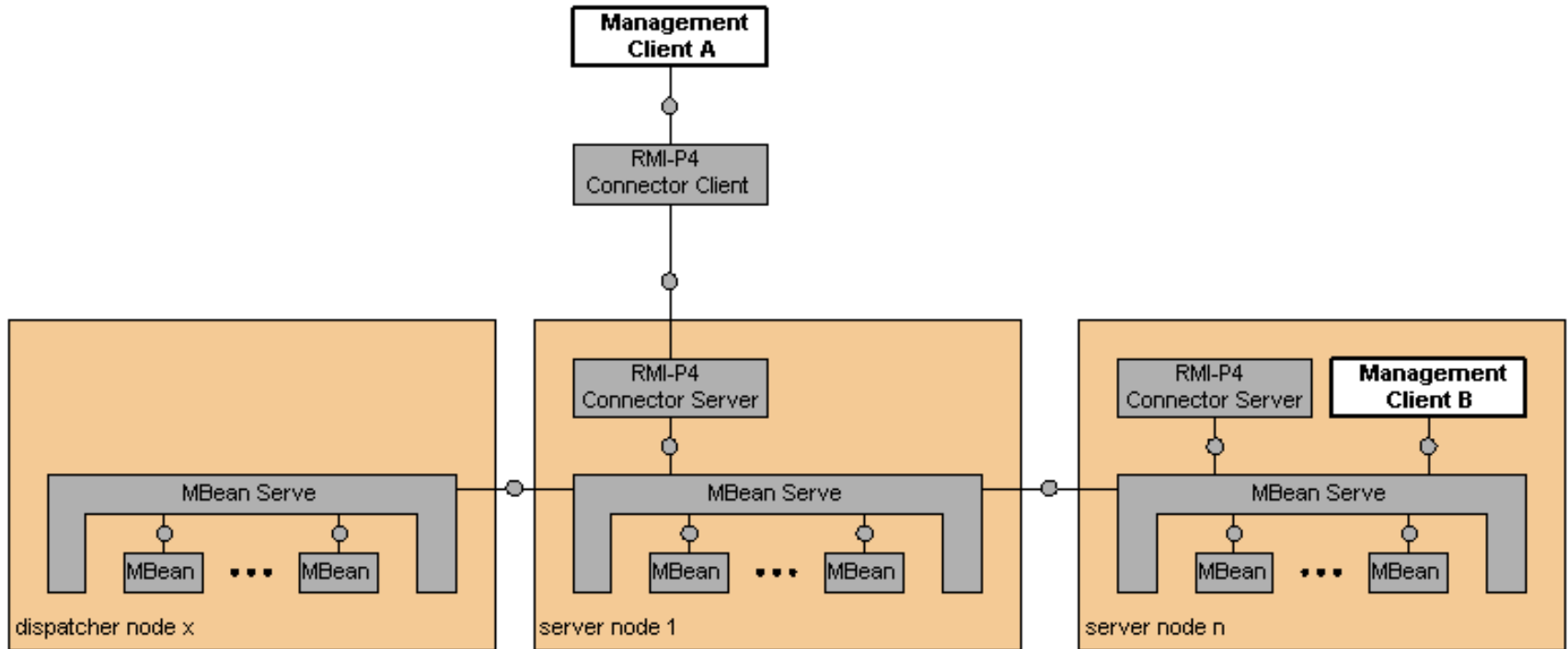
Clustered MBeans:

- Are used to manage node-independent resources
- Should be visible regardless on which node a client is attached
- Are replicated on each node in te cluster

Internal MBeans:

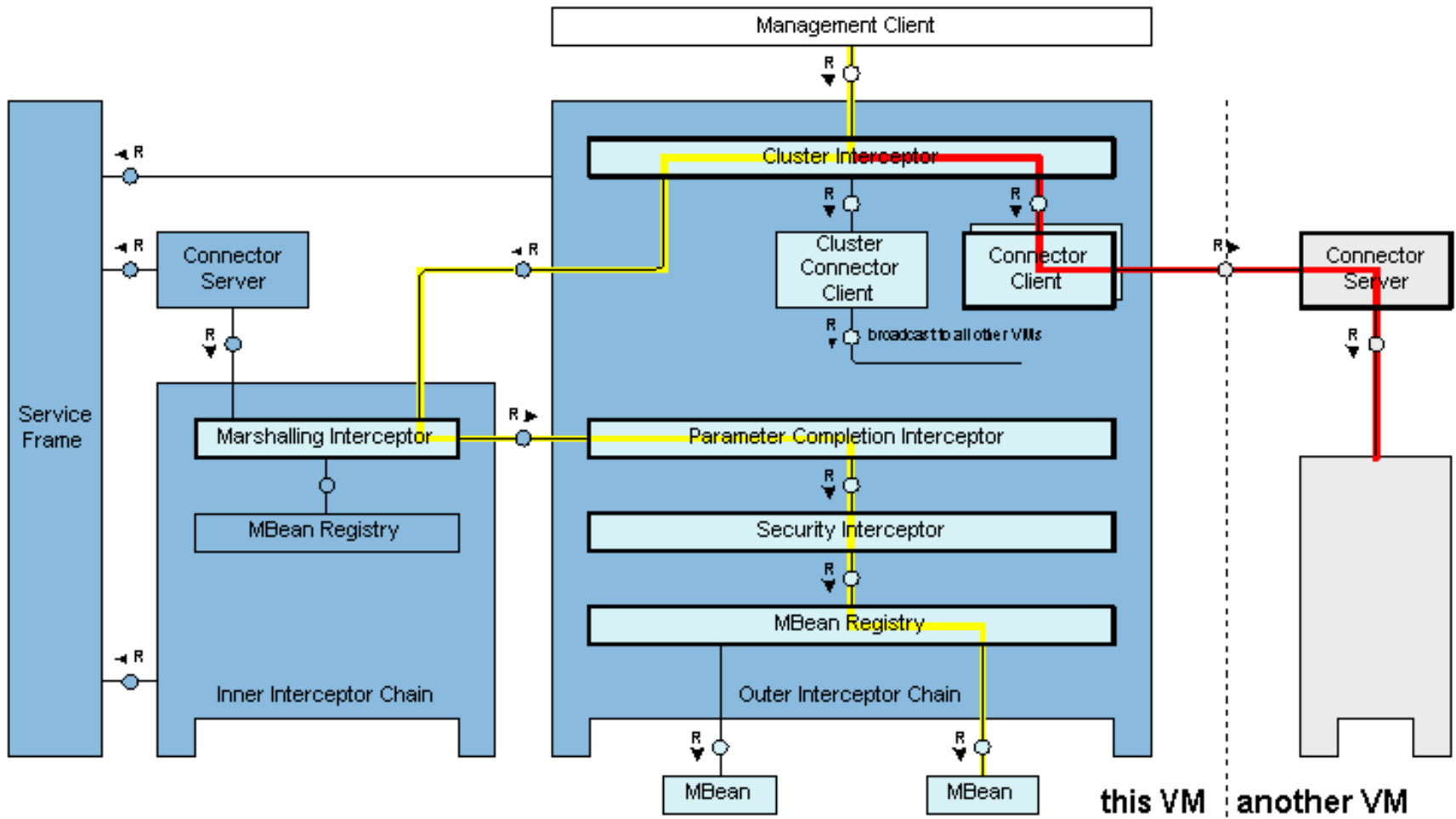
- Are visible only to clients, which are attached to the „local“ MBeanServer

Clustering MBeanServers



MBeanServers must be able to forward calls to local MBeans

Usage of Interceptors

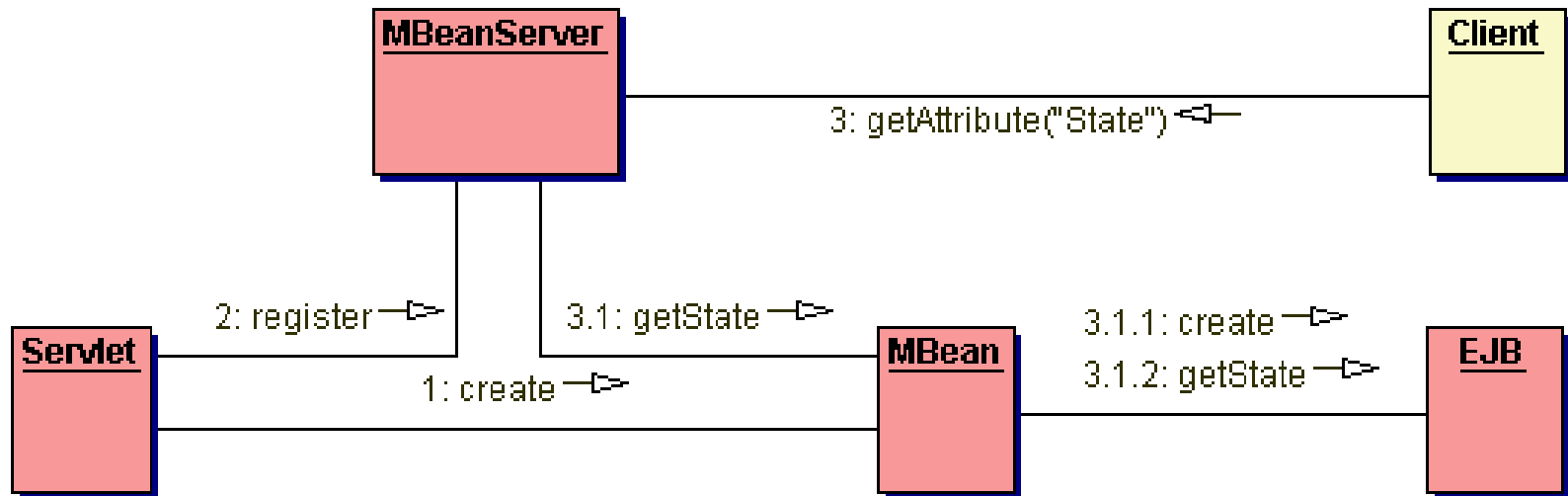




Management and Monitoring of J2EE Applications Using JMX

Some Ideas

A Pattern how to use JMX in J2EE



- In its init-method the servlet creates and registers the MBean
- The MBeanServer redirects client requests to the MBean
- The MBean uses an EJB to retrieve the status information, the client asked for

Reasons to use this Pattern

Management methods are best included in SessionBeans

Monitored states are best represented by EntityBeans

EJBs can not be MBeans

- **The MBeanServer can not hold a reference to an EJB**
- **There are potentially many EJB instances corresponding logically to one registered MBean**

The init method of a servlet allows the registration of the MBean during the startup of the application

Disadvantages of this pattern

EJBs can not broadcast JMX notifications

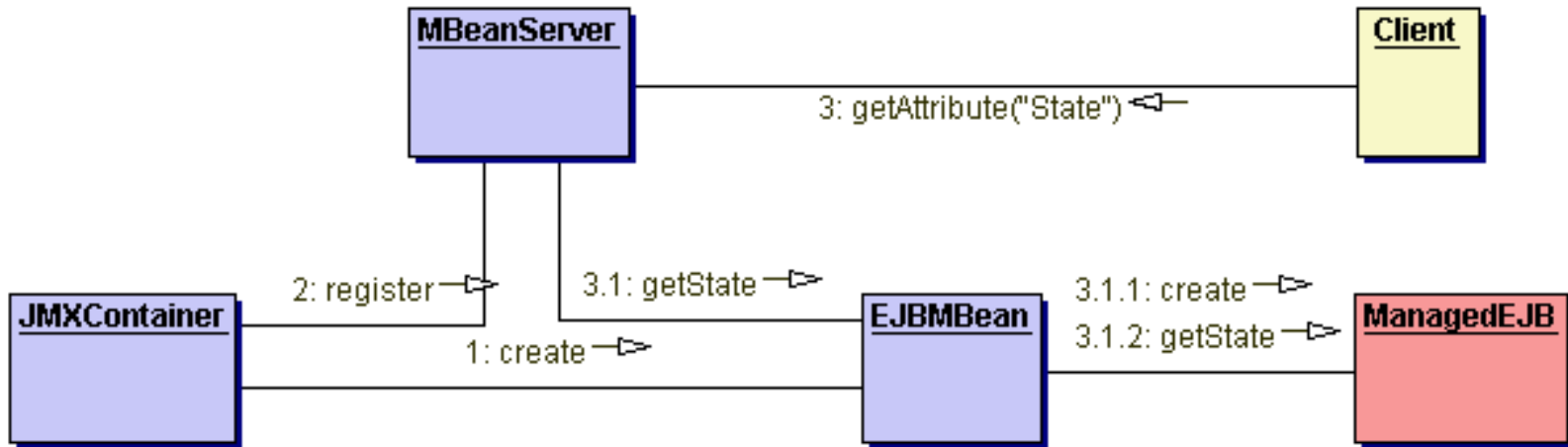
MBeans do not fit well to the J2EE Modell

- **Developer has to care about synchronization**
- **No support for declarative configuration**

Recurent tasks should best be taken by the framework

- A **JMXContainer** provides the runtime environment for MBeans
- Developers are freed from all sort of framework considerations
- They just programm the management functionality into a new sort of EJBs, **ManagedEJBs**

Proposal: JMXContainer & ManagedEJB



- The JMXContainer reads all required data to initialize the EJBMBean from a special deployment descriptor
- The JMXContainer instantiates and registers an EJBMBean during the startup of the application
- The EJBMBean works as a proxy for the ManagedEJB

ManagedEJB: Classes and Interfaces

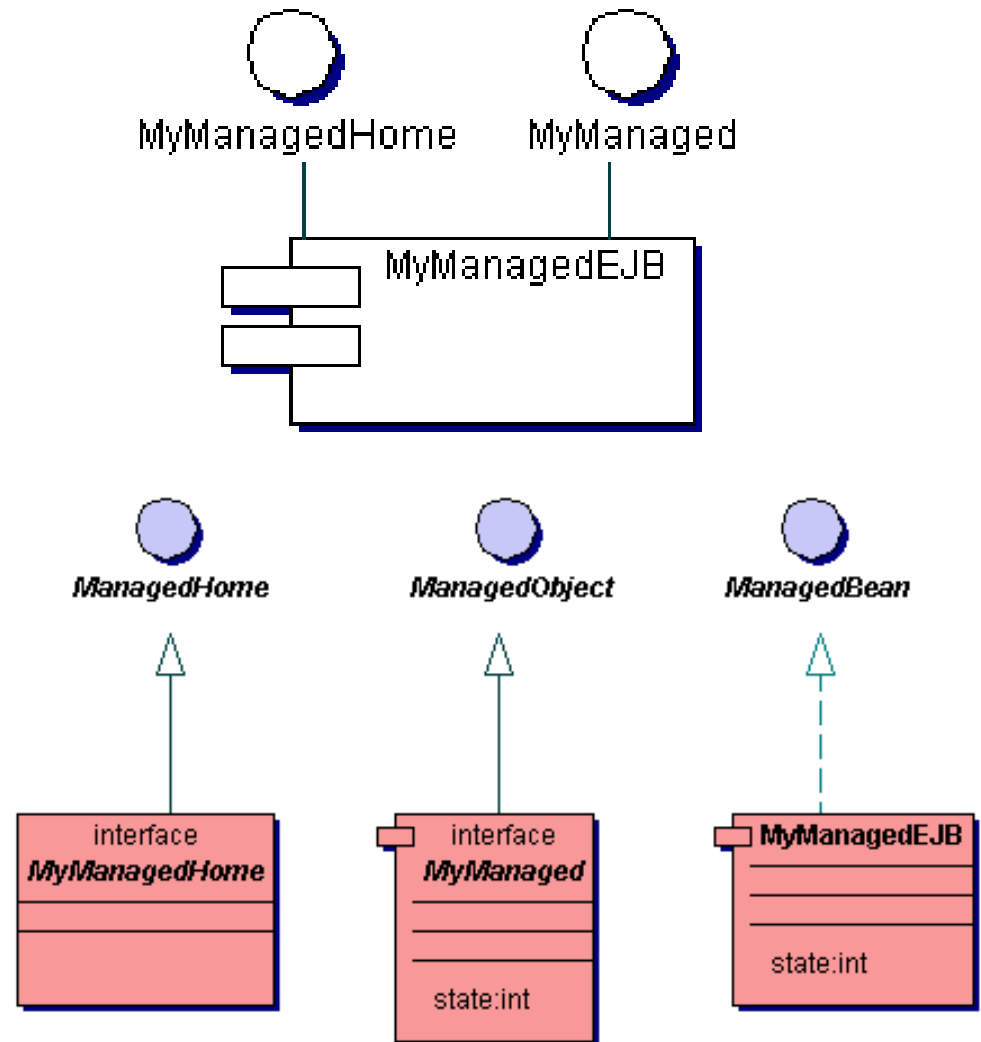
A ManagedEJB provides to clients two interfaces:

- A home interface to create and find the EJB
- A management interface to expose the management methods and attributes

The home interface extends ManagedHome

The management interface extends ManagedObject

The EJB class implements ManagedBean



Advantages of this Proposal

All the above mentioned disadvantages vanish

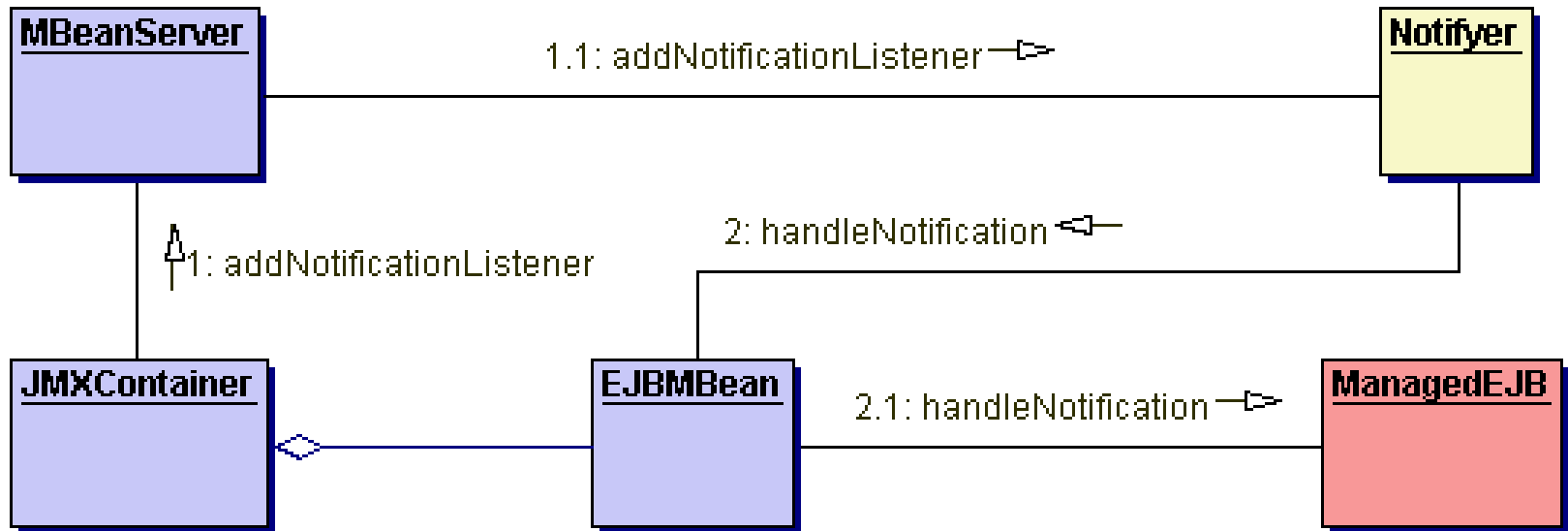
ManagedEJBs can broadcast JMX notifications

ManagedEJBs fit well to the J2EE Modell

- **Developers do not have to care about synchronization**
- **Configuration by declaration is possible**

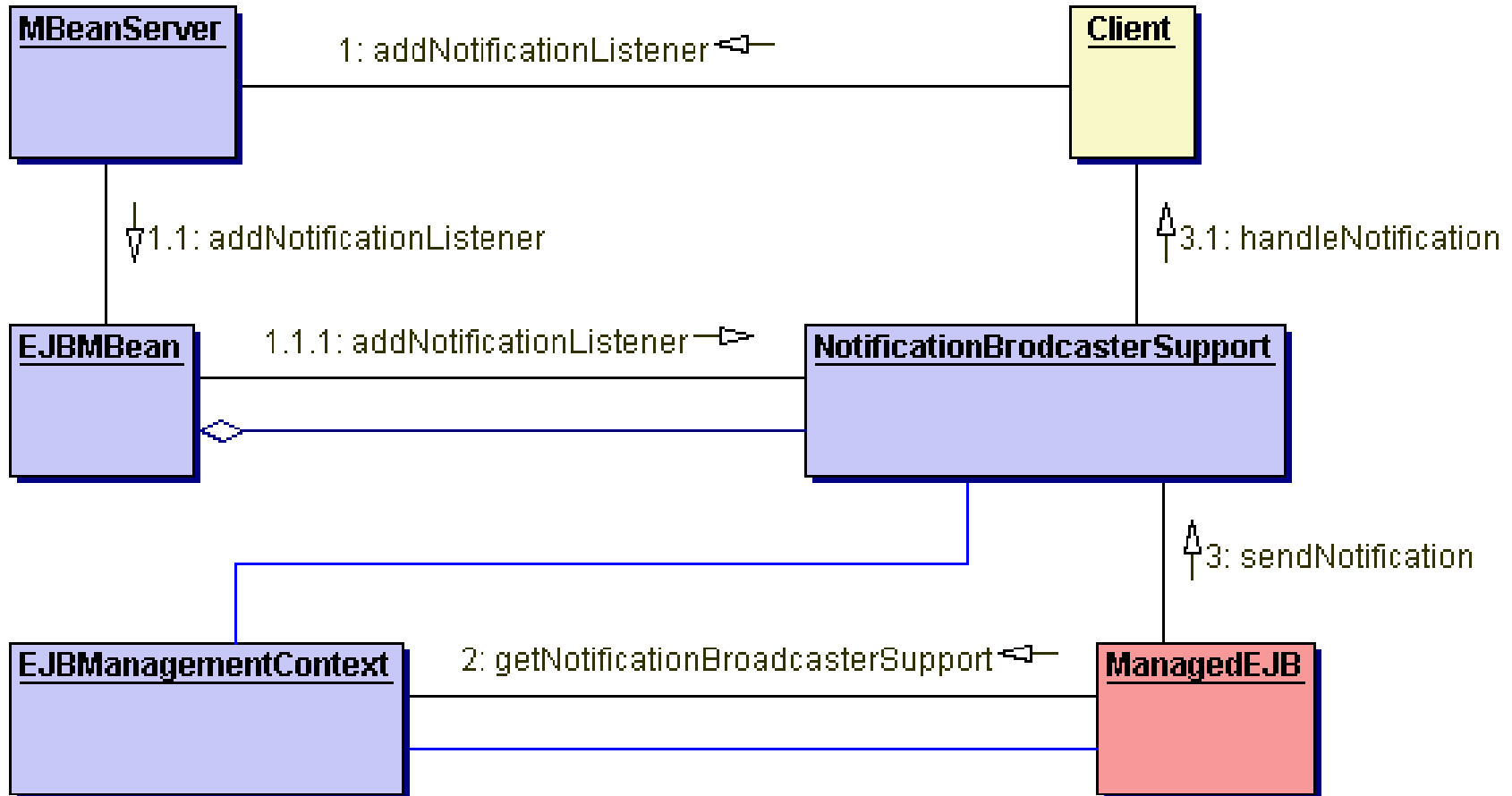
Recurrent tasks are done by the framework

ManagedEJBs as Notification Listener



- The JMXContainer gets the ObjectNames of the notifiers from the Deployment Descriptor
- During the startup of the application the JMXContainer adds the EJBMBean to the listeners of the notifier
- The notifier calls the handleNotification method of the EJBMBean, which delegates it to the ManagedEJB

ManagedEJBs as NotificationBroadcaster 1



ManagedEJBs as NotificationBroadcaster 2

- The JMXContainer adds a NotificationBroadcastSupport instance to the EJBManagementContext of the ManagedEJB
- The listener registers with the MBeanServer to get notifications from the Management EJB
- The ManagedEJB gets the NotificationBroadcastSupport instance from the context ...
- ... and invokes its sendNotification method
- The NotificationBroadcastSupport instance sends a notification to all registered listeners

The Deployment Descriptor

The Deployment Descriptor of ManagedEJBs extends the known descriptor of EJBs

In addition it contains the following elements:

- The required attributes of the `ObjectName` of the `EJBMBean`
 - The `JMXContainer` has to complete the given attributes to get a correct `ObjectName` according to a defined naming scheme
- A boolean element to signify whether the `ManagedEJB` is a `NotificationBroadcaster` or not
- A list of `ObjectNames` of `NotificationBroadcasters` with which the `ManagedEJB` should be registered as listeners

Responsibilities of the JMXContainer

- Create the MBeanServer during the startup of the J2EE server and make it available through JNDI
- Create a JMXConnectorServer and attach it to the MBeanServer
- Read and evaluate the Deployment Descriptor
- Complete the fragments of the ObjectNames according to a general naming scheme
- Instantiate and register the EJBMBean during the startup of the application
- Deregister the EJBMBean when the application is shut down
- Registers the EJBMBean as listener for JMX notifications
- Adds a NotificationBroadcastSupport to the context of the ManagedEJB

Only a few additions to the EJB specification are required, because the biggest job is done by the JMXContainer

■ New sorts of EJBs

- Issue: Should all types of EJBs supported?

■ Additional Interfaces: ManagedHome, ManagedObject, ManagedBean, EJBManagementContext

- No part of this publication may be reproduced or transmitted in any form or for any purpose without the express permission of SAP AG. The information contained herein may be changed without prior notice.
- Some software products marketed by SAP AG and its distributors contain proprietary software components of other software vendors.
- Microsoft®, WINDOWS®, NT®, EXCEL®, Word®, PowerPoint® and SQL Server® are registered trademarks of Microsoft Corporation.
- IBM®, DB2®, DB2 Universal Database, OS/2®, Parallel Sysplex®, MVS/ESA, AIX®, S/390®, AS/400®, OS/390®, OS/400®, iSeries, pSeries, xSeries, zSeries, z/OS, AFP, Intelligent Miner, WebSphere®, Netfinity®, Tivoli®, Informix and Informix® Dynamic Server™ are trademarks of IBM Corporation in USA and/or other countries.
- ORACLE® is a registered trademark of ORACLE Corporation.
- UNIX®, X/Open®, OSF/1®, and Motif® are registered trademarks of the Open Group.
- Citrix®, the Citrix logo, ICA®, Program Neighborhood®, MetaFrame®, WinFrame®, VideoFrame®, MultiWin® and other Citrix product names referenced herein are trademarks of Citrix Systems, Inc.
- HTML, DHTML, XML, XHTML are trademarks or registered trademarks of W3C®, World Wide Web Consortium, Massachusetts Institute of Technology.
- JAVA® is a registered trademark of Sun Microsystems, Inc.
- JAVASCRIPT® is a registered trademark of Sun Microsystems, Inc., used under license for technology invented and implemented by Netscape.
- MarketSet and Enterprise Buyer are jointly owned trademarks of SAP AG and Commerce One.
- SAP, SAP Logo, R/2, R/3, mySAP, mySAP.com and other SAP products and services mentioned herein as well as their respective logos are trademarks or registered trademarks of SAP AG in Germany and in several other countries all over the world. All other product and service names mentioned are trademarks of their respective companies.

- Weitergabe und Vervielfältigung dieser Publikation oder von Teilen daraus sind, zu welchem Zweck und in welcher Form auch immer, ohne die ausdrückliche schriftliche Genehmigung durch SAP AG nicht gestattet. In dieser Publikation enthaltene Informationen können ohne vorherige Ankündigung geändert werden.
- Die von SAP AG oder deren Vertriebsfirmen angebotenen Softwareprodukte können Softwarekomponenten auch anderer Softwarehersteller enthalten.
- Microsoft®, WINDOWS®, NT®, EXCEL®, Word®, PowerPoint® und SQL Server® sind eingetragene Marken der Microsoft Corporation.
- IBM®, DB2®, DB2 Universal Database, OS/2®, Parallel Sysplex®, MVS/ESA, AIX®, S/390®, AS/400®, OS/390®, OS/400®, iSeries, pSeries, xSeries, zSeries, z/OS, AFP, Intelligent Miner, WebSphere®, Netfinity®, Tivoli®, Informix und Informix® Dynamic Server™ sind Marken der IBM Corporation in den USA und/oder anderen Ländern.
- ORACLE® ist eine eingetragene Marke der ORACLE Corporation.
- UNIX®, X/Open®, OSF/1® und Motif® sind eingetragene Marken der Open Group.
- Citrix®, das Citrix-Logo, ICA®, Program Neighborhood®, MetaFrame®, WinFrame®, VideoFrame®, MultiWin® und andere hier erwähnte Namen von Citrix-Produkten sind Marken von Citrix Systems, Inc.
- HTML, DHTML, XML, XHTML sind Marken oder eingetragene Marken des W3C®, World Wide Web Consortium, Massachusetts Institute of Technology.
- JAVA® ist eine eingetragene Marke der Sun Microsystems, Inc.
- JAVASCRIPT® ist eine eingetragene Marke der Sun Microsystems, Inc., verwendet unter der Lizenz der von Netscape entwickelten und implementierten Technologie.
- MarketSet und Enterprise Buyer sind gemeinsame Marken von SAP AG und Commerce One.
- SAP, SAP Logo, R/2, R/3, mySAP, mySAP.com und weitere im Text erwähnte SAP-Produkte und -Dienstleistungen sowie die entsprechenden Logos sind Marken oder eingetragene Marken der SAP AG in Deutschland und anderen Ländern weltweit. Alle anderen Namen von Produkten und Dienstleistungen sind Marken der jeweiligen Firmen.



Management and Monitoring of a J2EE **Server** and **Applications** Using **JMX**

Reinhold Kautzleben, Gregor Frey
Speaker Title, SAP AG

THE BEST-RUN BUSINESSES RUN SAP 

How much JMX is required to be in J2EE?

JMX 1.2 belongs to the list of required APIs that a J2EE 1.4 compliant server has to provision. But there are some restrictions:

„The only JMX support required is specified in the J2EE Management specification.“ (J2EE 6.17)

So what JMX support does the J2EE Management specification require?

„The MEJB component exposes the manageable resources on a J2EE platform as JMX Managed Beans (MBeans) and requires an implementation of the JMX public APIs specified by the Java Management Extensions Instrumentation and Agent Specification, v1.1.“

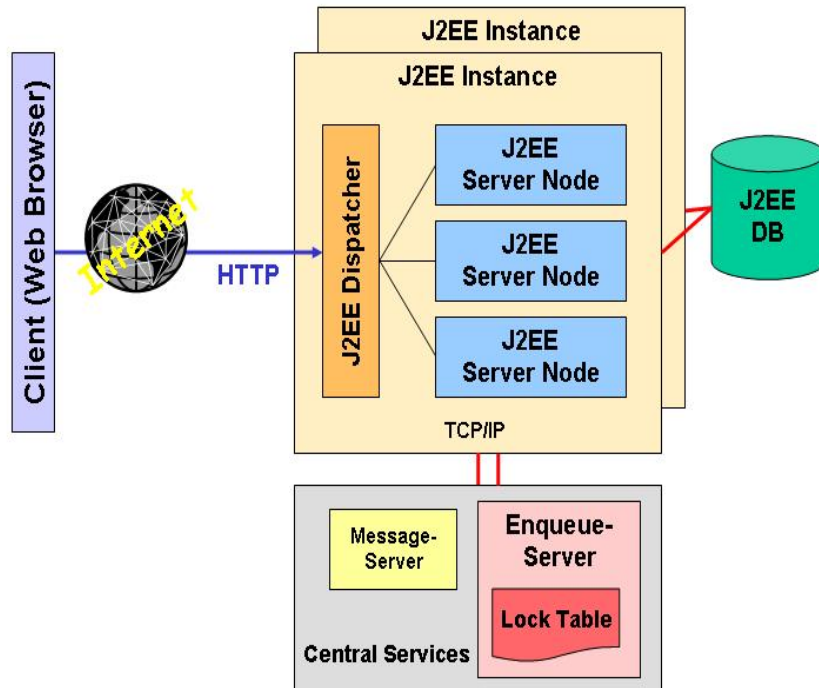
This leaves room for interpretation 😊

Management and Monitoring of a J2EE Server Using JMX

Discussed using the Example of
the SAP WebAS

THE BEST-RUN BUSINESSES RUN SAP 

Cluster Architecture of SAP J2EE



To reach a better scalability the SAP J2EEEngine contains a cluster of J2EE server processes

In every server process there is exactly one MBeanServer running

All MBeans register with the local MBeanServer (and only with this)

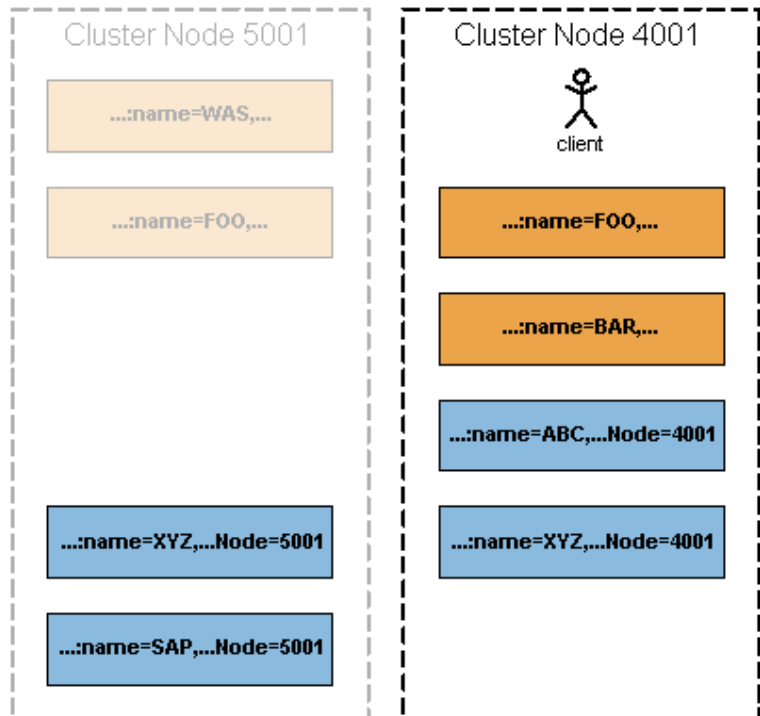
Problem: Management Clients connect to one and only one MBeanServer – How can they access MBeans in other cluster-nodes?

Visibility of MBeans

A client connected to a certain MBeanServer sees

■ All MBeans registered with the „local“ MBeanServer

■ All MBeans, which can be uniquely identified across the cluster



Local MBeans:

- Are used to manage node specific resources
- Should be visible regardless on which node a client is attached
- Are identified by an ObjectName, which is clusterwide unique

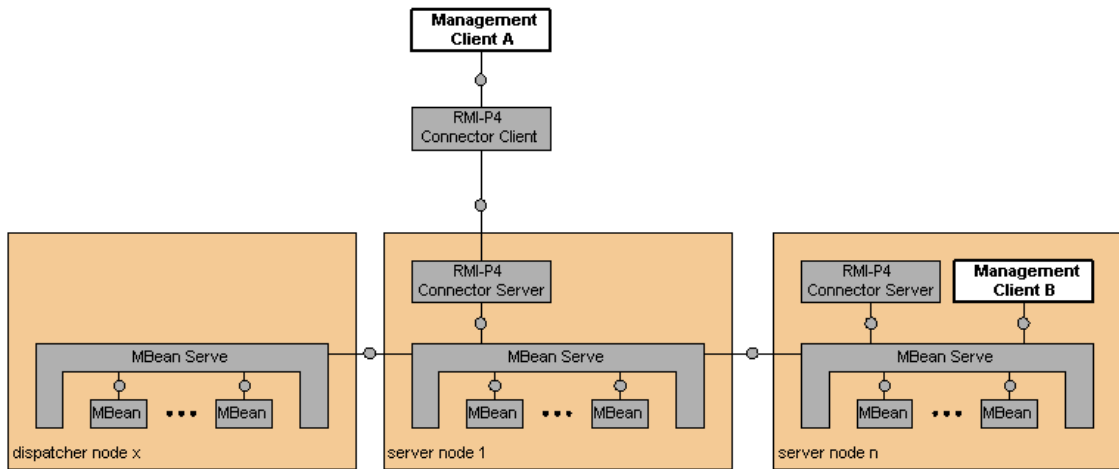
Clustered MBeans:

- Are used to manage node-independent resources
- Should be visible regardless on which node a client is attached
- Are replicated on each node in te cluster

Internal MBeans:

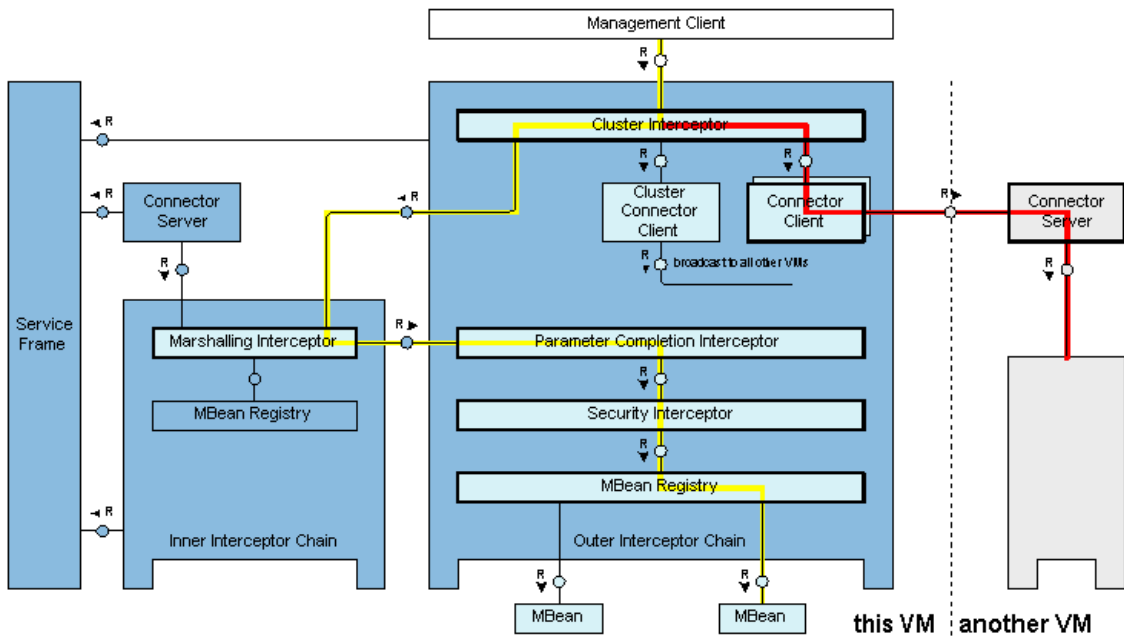
- Are visible only to clients, which are attached to the „local“ MBeanServer

Clustering MBeanServers



MBeanServers must be able to forward calls to local MBeans

Usage of Interceptors



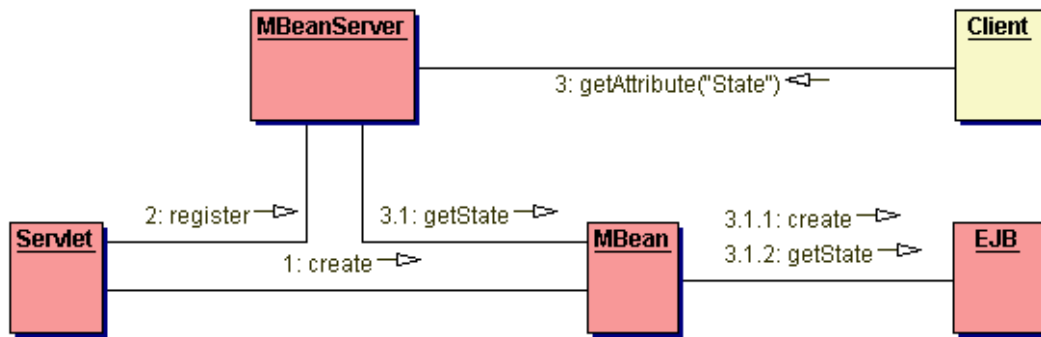


Management and Monitoring of J2EE Applications Using JMX

Some Ideas

THE BEST-RUN BUSINESSES RUN SAP 

A Pattern how to use JMX in J2EE



- In its init-method the servlet creates and registers the MBean
- The MBeanServer redirects client requests to the MBean
- The MBean uses an EJB to retrieve the status information, the client asked for

Management methods are best included in SessionBeans

Monitored states are best represented by EntityBeans

EJBs can not be MBeans

- The MBeanServer can not hold a reference to an EJB
- There are potentially many EJB instances corresponding logically to one registered MBean

The init method of a servlet allows the registration of the MBean during the startup of the application

Disadvantages of this pattern

EJBs can not broadcast JMX notifications

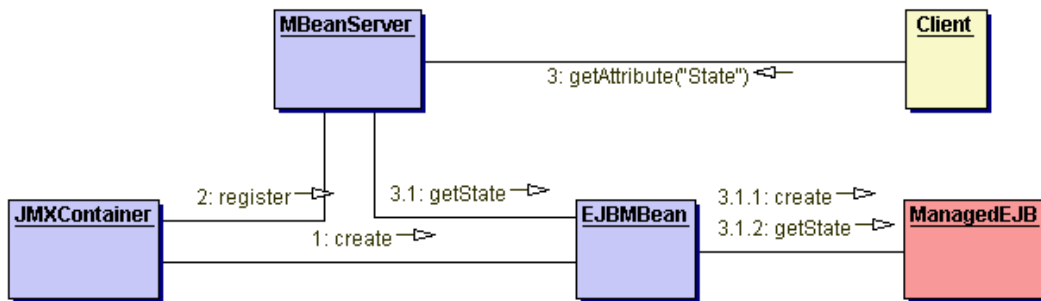
MBeans do not fit well to the J2EE Modell

- **Developer has to care about synchronization**
- **No support for declarative configuration**

Recurent tasks should best be taken by the framework

- A **JMXContainer** provides the runtime environment for MBeans
- Developers are freed from all sort of framework considerations
- They just programm the management functionality into a new sort of EJBs, **ManagedEJBs**

Proposal: JMXContainer & ManagedEJB



- The JMXContainer reads all required data to initialize the EJBMBean from a special deployment descriptor
- The JMXContainer instantiates and registers an EJBMBean during the startup of the application
- The EJBMBean works as a proxy for the ManagedEJB

ManagedEJB: Classes and Interfaces

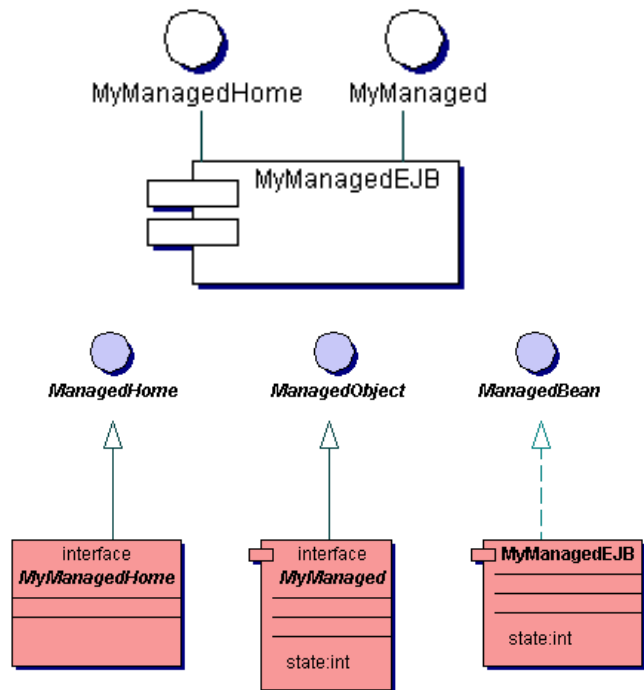
A ManagedEJB provides to clients two interfaces:

- A home interface to create and find the EJB
- A management interface to expose the management methods and attributes

The home interface extends ManagedHome

The management interface extends ManagedObject

The EJB class implements ManagedBean



Advantages of this Proposal

All the above mentioned disadvantages vanish

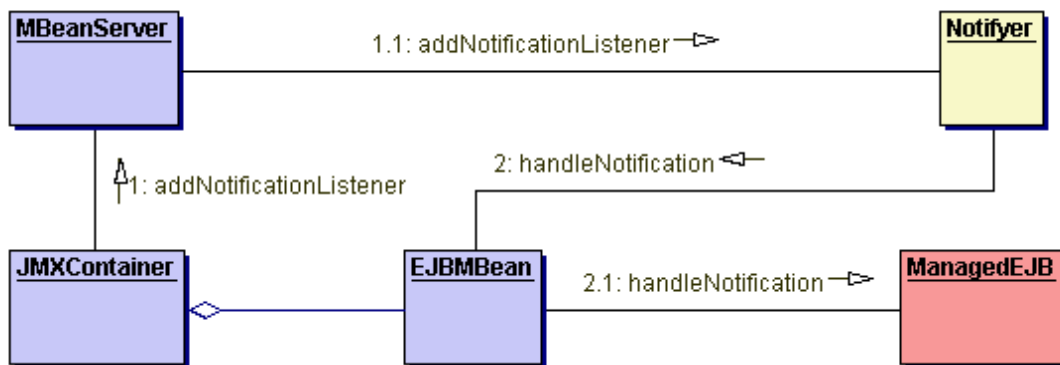
ManagedEJBs can broadcast JMX notifications

ManagedEJBs fit well to the J2EE Modell

- **Developers do not have to care about synchronization**
- **Configuration by declaration is possible**

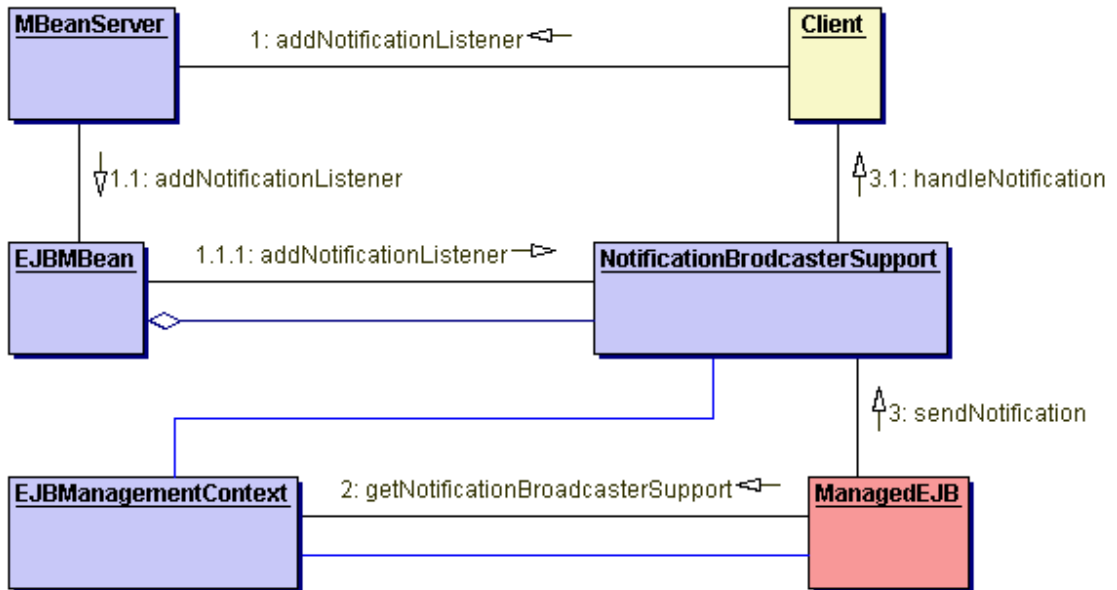
Recurrent tasks are done by the framework

ManagedEJBs as Notification Listener



- The JMXContainer gets the ObjectNames of the notifiers from the Deployment Descriptor
- During the startup of the application the JMXContainer adds the EJBMBean to the listeners of the notifier
- The notifier calls the handleNotification method of the EJBMBean, which delegates it to the ManagedEJB

ManagedEJBs as NotificationBroadcaster 1



ManagedEJBs as NotificationBroadcaster 2

- The JMXContainer adds a NotificationBroadcastSupport instance to the EJBManagementContext of the ManagedEJB
- The listener registers with the MBeanServer to get notifications from the Management EJB
- The ManagedEJB gets the NotificationBroadcastSupport instance from the context ...
- ... and invokes its sendNotification method
- The NotificationBroadcastSupport instance sends a notification to all registered listeners

The Deployment Descriptor

The Deployment Descriptor of ManagedEJBs extends the known descriptor of EJBs

In addition it contains the following elements:

- The required attributes of the `ObjectName` of the `EJBMBean`
 - The `JMXContainer` has to complete the given attributes to get a correct `ObjectName` according to a defined naming scheme
- A boolean element to signify whether the `ManagedEJB` is a `NotificationBroadcaster` or not
- A list of `ObjectNames` of `NotificationBroadcasters` with which the `ManagedEJB` should be registered as listeners

Responsibilities of the JMXContainer

- Create the MBeanServer during the startup of the J2EE server and make it available through JNDI
- Create a JMXConnectorServer and attach it to the MBeanServer
- Read and evaluate the Deployment Descriptor
- Complete the fragments of the ObjectNames according to a general naming scheme
- Instantiate and register the EJBMBean during the startup of the application
- Deregister the EJBMBean when the application is shut down
- Registers the EJBMBean as listener for JMX notifications
- Adds a NotificationBroadcastSupport to the context of the ManagedEJB

Additions to the EJB Spec

Only a few additions to the EJB specification are required, because the biggest job is done by the JMXContainer

- **New sorts of EJBs**

- **Issue: Should all types of EJBs supported?**

- **Additional Interfaces: ManagedHome, ManagedObject, ManagedBean, EJBManagementContext**

- No part of this publication may be reproduced or transmitted in any form or for any purpose without the express permission of SAP AG. The information contained herein may be changed without prior notice.
- Some software products marketed by SAP AG and its distributors contain proprietary software components of other software vendors.
- Microsoft®, WINDOWS®, NT®, EXCEL®, Word®, PowerPoint® and SQL Server® are registered trademarks of Microsoft Corporation.
- IBM®, DB2®, DB2 Universal Database, OS/2®, Parallel Sysplex®, MVS/ESA, AIX®, S/390®, AS/400®, OS/390®, OS/400®, iSeries, pSeries, xSeries, zSeries, z/OS, AFP, Intelligent Miner, WebSphere®, Neffinity®, Tivoli®, Informix and Informix® Dynamic Server™ are trademarks of IBM Corporation in USA and/or other countries.
- ORACLE® is a registered trademark of ORACLE Corporation.
- UNIX®, X/Open®, OSF/1®, and Motif® are registered trademarks of the Open Group.
- Citrix®, the Citrix logo, ICA®, Program Neighborhood®, MetaFrame®, WinFrame®, VideoFrame®, MultiWin® and other Citrix product names referenced herein are trademarks of Citrix Systems, Inc.
- HTML, DHTML, XML, XHTML are trademarks or registered trademarks of W3C®, World Wide Web Consortium, Massachusetts Institute of Technology.
- JAVA® is a registered trademark of Sun Microsystems, Inc.
- JAVASCRIPT® is a registered trademark of Sun Microsystems, Inc., used under license for technology invented and implemented by Netscape.
- MarketSet and Enterprise Buyer are jointly owned trademarks of SAP AG and Commerce One.
- SAP, SAP Logo, R/2, R/3, mySAP, mySAP.com and other SAP products and services mentioned herein as well as their respective logos are trademarks or registered trademarks of SAP AG in Germany and in several other countries all over the world. All other product and service names mentioned are trademarks of their respective companies.

- Weitergabe und Vervielfältigung dieser Publikation oder von Teilen daraus sind, zu welchem Zweck und in welcher Form auch immer, ohne die ausdrückliche schriftliche Genehmigung durch SAP AG nicht gestattet. In dieser Publikation enthaltene Informationen können ohne vorherige Ankündigung geändert werden.
- Die von SAP AG oder deren Vertriebsfirmen angebotenen Softwareprodukte können Softwarekomponenten auch anderer Softwarehersteller enthalten.
- Microsoft®, WINDOWS®, NT®, EXCEL®, Word®, PowerPoint® und SQL Server® sind eingetragene Marken der Microsoft Corporation.
- IBM®, DB2®, DB2 Universal Database, OS/2®, Parallel Sysplex®, MVS/ESA, AIX®, S/390®, AS/400®, OS/390®, OS/400®, iSeries, pSeries, xSeries, zSeries, z/OS, AFP, Intelligent Miner, WebSphere®, Netfinity®, Tivoli®, Informix und Informix® Dynamic Server™ sind Marken der IBM Corporation in den USA und/oder anderen Ländern.
- ORACLE® ist eine eingetragene Marke der ORACLE Corporation.
- UNIX®, X/Open®, OSF/1® und Motif® sind eingetragene Marken der Open Group.
- Citrix®, das Citrix-Logo, ICA®, Program Neighborhood®, MetaFrame®, WinFrame®, VideoFrame®, MultiWin® und andere hier erwähnte Namen von Citrix-Produkten sind Marken von Citrix Systems, Inc.
- HTML, DHTML, XML, XHTML sind Marken oder eingetragene Marken des W3C®, World Wide Web Consortium, Massachusetts Institute of Technology.
- JAVA® ist eine eingetragene Marke der Sun Microsystems, Inc.
- JAVASCRIPT® ist eine eingetragene Marke der Sun Microsystems, Inc., verwendet unter der Lizenz der von Netscape entwickelten und implementierten Technologie.
- MarketSet und Enterprise Buyer sind gemeinsame Marken von SAP AG und Commerce One.
- SAP, SAP Logo, R/2, R/3, mySAP, mySAP.com und weitere im Text erwähnte SAP-Produkte und -Dienstleistungen sowie die entsprechenden Logos sind Marken oder eingetragene Marken der SAP AG in Deutschland und anderen Ländern weltweit. Alle anderen Namen von Produkten und Dienstleistungen sind Marken der jeweiligen Firmen.