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Security Policy File Best Practices

For Your Java/JDBC Modules

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Program Agenda

1. Java Security Manager
2. Application Servers
3. Policy File
4. Detailed Example JDBC
5. Q&A

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Java Security Manager

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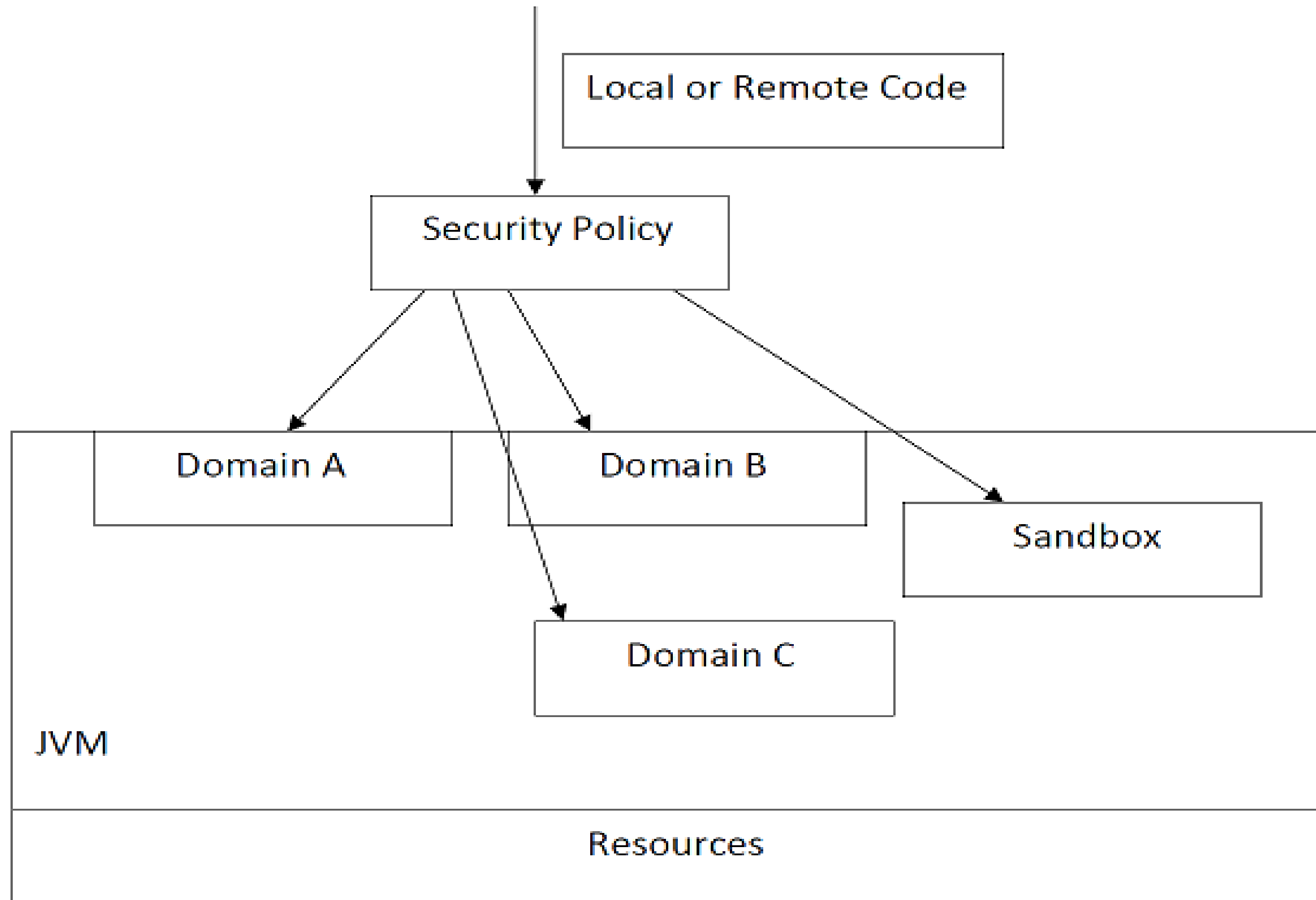
Security Model



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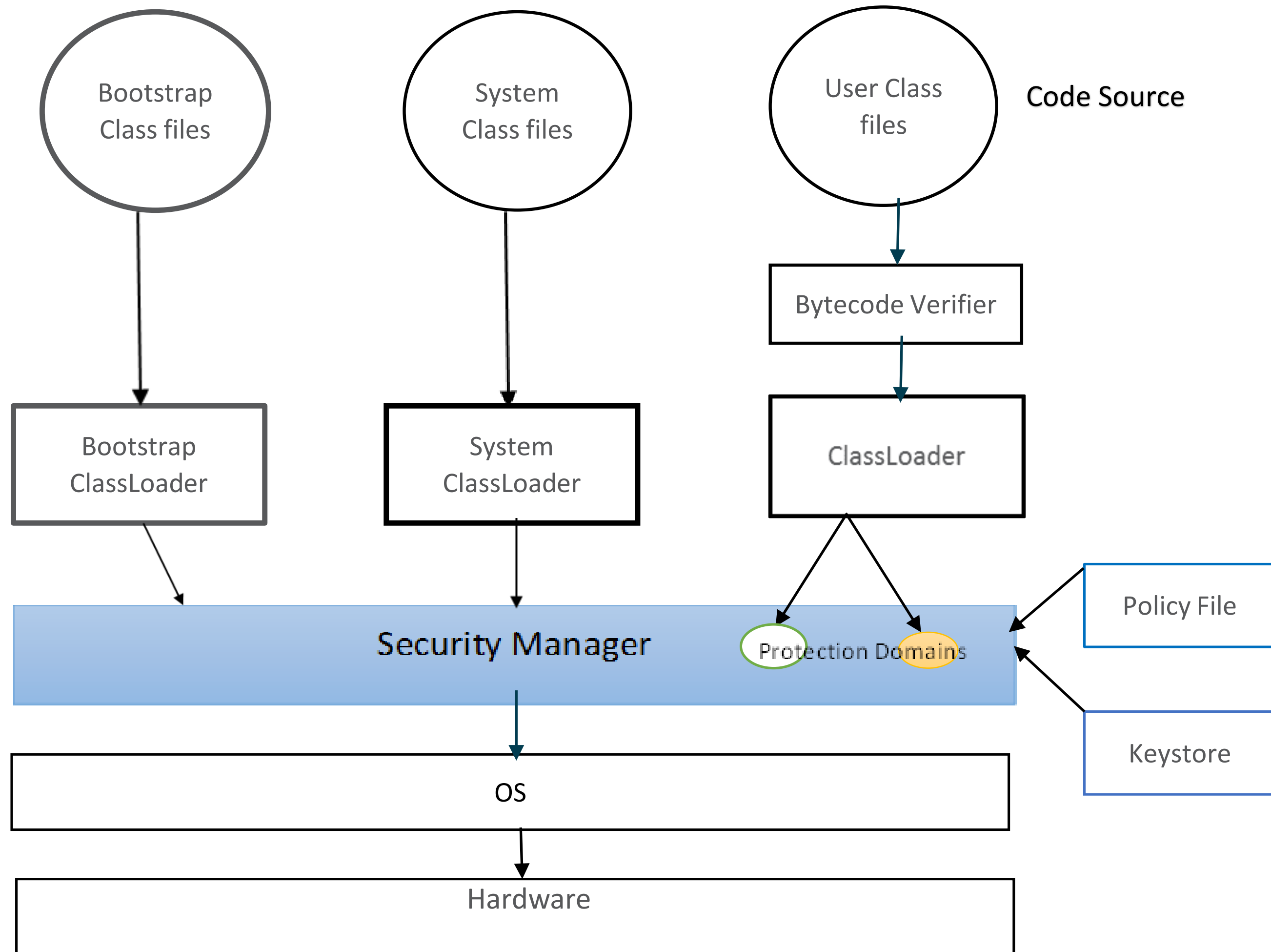
Security Model



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Java Security Manager

- Provides additional protection for resources running in a JVM.
- Prevents untrusted code from performing actions that are restricted by the Java security policy file.
- The Java Security Manager uses the Java security policy file to enforce a set of permissions granted to classes.
- The permissions allow specified classes to permit or not permit certain runtime operations.

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Protection Domains

- Set of objects that are currently directly accessible by a principal.
- Principal is an entity in the computer system to which permissions are granted.
- Serves to group and to isolate between units of protection.

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Application Servers

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Web Logic Server

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FUSION MIDDLEWARE
WEBLOGIC SERVER

- Specify the `-Djava.security.policy` and `-Djava.security.manager` arguments when starting WebLogic Server.
- WLS provides a sample Java security policy file located at `$WL_HOME/wlserver/server/lib/weblogic.policy`
- If you do not specify a security policy file, the default security policies defined in the `java.policy` file in the `$JAVA_HOME/jre/lib/security` directory

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Tomcat

- Configure the `catalina.policy` file for use with a Security Manager
- Start a Security Manager in place by using the `"-security"` option:

```
$CATALINA_HOME/bin/catalina.sh start -security   (Unix)
 %CATALINA_HOME%\bin\catalina start -security    (Windows)
```


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JBoss

- Specify the `-Djava.security.policy` and `-Djava.security.manager` arguments in `$JBOSS_HOME/server/$PROFILE/run.conf` when starting JBoss.
- JBoss provides a sample Java security policy file located at `$JBOSS_HOME/bin/server.policy.cert`
- You can overrirde default security policy file using == operator while setting `-Djava.security.policy`.

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WebSphere

- Open the WebSphere Application Server Administrative Console.
- Select and expand "Security" on the left navigation pane.
- Click on Global security.
- Check the checkbox for "Enforce Java 2 security".
- Click "Apply".
- Click "Save" to save your workspace changes to the master configuration.
  - The server may need to be restarted for the changes to take effect.
- java.policy – `app_server_root/java/jre/lib/security/java.policy`

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Policy File

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Policy File Location

- The system policy file `java.home/lib/security/java.policy`
- The user policy file `user.home/.java.policy`
- Policy file locations are specified in the security properties file

  `java.home/lib/security/java.security`

  Property Name:

  – policy.url.*n*=*URL*

  – policy.provider=sun.security.provider.PolicyFile
- -Djava.security.policy=mypolicy
  -Djava.security.policy==*someURL*
  policy.allowSystemProperty=false then it ignores. Default is true.

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JSM Assign Permissions

- Every class is associated with a *protection domain*, which consists of:
  - A link to the defining class loader of the class
  - A *code source* (a URL that identifies the code)
  - A *permission collection* (a set of assigned permissions)
  - An array of principals, specific to JAAS
- The protection domain permissions are built from the security policy
- Limited doPrivileged - run privileged actions with only a subset of your total possible permissions (Java 8)

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JSM Checking Permissions

- The security manager examines the current *access control context*
- This is the accumulation of the protection domains of classes from the call stack
  - Stopping only at the last call to AccessController.doPrivileged()
  - The access control context is inherited to newly created threads
- The permission check passes only if *all* the security domains in the access control context have granted the permission

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Setup Policy File

- A policy file is an ASCII text file and can be composed via
  - A text editor
  - The Graphical Policy Tool utility
- The Policy Tool saves you typing and eliminates the need for you to know the required syntax of policy files, thus reducing errors
- To start Policy Tool, simply type the following at the command line:
  - `policytool`

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Policy File Syntax

- A policy configuration file essentially contains a "keystore" entry, and contains zero or more "grant" entries

- A *keystore* is a database of private keys and their associated digital certificates such as X.509 certificate chains authenticating the corresponding public keys.

- The **keytool** utility is used to create and administer keystores.

- Look up the public keys of the signers specified in the grant entries of the file.
  - `keystore "some_keystore_url", "keystore_type", "keystore_provider";`
  - `keystorePasswordURL "some_password_url";`

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Policy File Syntax

- Grant Entries

- Each **grant entry** includes
  - one or more "permission entries“.
  - preceded by optional codeBase, signedBy, and principal name/value pairs

```
grant signedBy "signer_names", codeBase "URL",
principal principal_class_name "principal_name", ...
{permission permission_class_name "target_name", "action",
signedBy "signer_names“;... };
```

- A `signedBy` value indicates the alias for a certificate stored in the keystore.

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Policy File Syntax

- The Principal Entries
- `principal` *`principal_class_name`* `"`*`principal_name`*`",`
- The `principal` set is associated with the executing code by way of a Subject.
- grant principal javax.security.auth.x500.X500Principal "cn=Mice" { permission java.io.FilePermission "/home/Mice", "read, write"; };

  This permits any code executing as the X500Principal, "cn=Mice", permission to read and write to "/home/Mice".

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Policy File Syntax

- The Permission Entries

  grant signedBy "*signer_names*", codeBase "*URL*", ... {
  permission *permission_class_name* "*target_name*",
  "*action*", signedBy "*signer_names*"; ... };

- The *permission_class_name* actually be a specific permission
  e.g. `java.io.FilePermission`, `java.lang.RuntimePermission`

- When you specify `java.io.FilePermission` then
  "`target_name`" is a file path

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Policy File Syntax

- The "*action*" is required for many permission types, such as `java.io.FilePermission`. e.g. “read”, “write” etc.
- The signedBy name/value pair for a permission entry is optional. If present, it indicates a signed permission.
  - e.g. suppose you have the following grant entry:

```
grant { permission Foo "foobar", signedBy "FooAbc"; };
```

Permission of type *Foo* is granted if the Foo.class permission was placed in a JAR file and the JAR file was signed by the certificate specified by the "FooAbc" alias.

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Policy File Syntax

- Items must appear in the specified order (permission, *permission_class_name*, `"`*`target_name`*`", "`*`action`*`", and signedBy "`*`signer_names`*`"`).
- An entry is terminated with a semicolon.
- Case is unimportant for the identifiers
  - e.g. permission, signedBy etc.
- Case is significant for the *permission_class_name*
- Property expansion is similar to expanding variables in a shell
  - `${some.property}`

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Policy File Strategy

- Grant all permissions
  - permission `java.security.AllPermission`;
- Grant least permissions
  - Start with a blank policy file
  - Run the application
  - Check the thrown security exception
  - Add the smallest-grained permission possible in the policy file that fix exception
  - Repeat above 3 steps until application run without exception.
- Regularly review security policy files to accommodate any updates in application.

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Review Policy Files

- Review all *.policy files
- Policy files precedence order
- Remove unused grants
- Add extra permissions to applications or modules that require them, not all applications.
- Document your changes
- Use –Djava.security.debug=all to troubleshoot security failures

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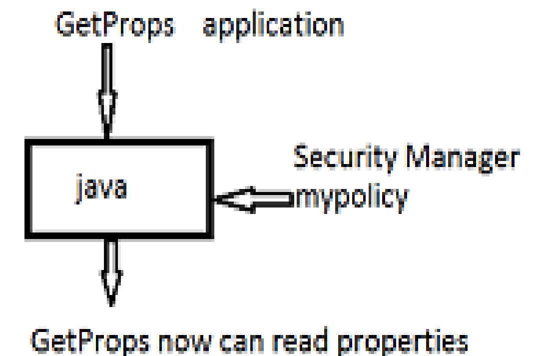
JSM and Policy File

- The application program makes request for GetProps
- The Java API ask Security Manager if this is allowed.
- The Security Manager uses mypolicy file to check permissions.
- If disallows then Security Manager throws Security Exception, which Java API throws to Application.
- If allows then Java API completes operation and returns normally.



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Permissions Outside of Policy File

- Virtually all of the permissions granted to code comes from policy files
- Advanced applications are allowed to grant additional permissions to code that they load
- Standard Java class loaders grant some additional permissions to every class that they load
  - File class loader always grant permission to read files in the directory
  - HTTP class loader always grant permission to establish a connection and to accept a connection from that host.

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Security Policy API

- java.security.Policy implements
  - getPolicy() returns current policy.
    Needs SecurityPermission getPolicy

  - setPolicy() enables you to set a new system-wide security policy
    Needs SecurityPermission setPolicy

- New policy must extend the Policy class and implement the getPermissions() and refresh()

- Alternatively, the default policy implementation can be specified with a policy.provider property in the java.security file

  policy.provider=com.mycompany.security.GenericPolicy

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Detailed Example

Oracle Database JDBC

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Java SecurityManager

- Java does not enable a SecurityManager by default
  Java in the database always has a SecurityManager

- Without a SecurityManager Java is not secure

- If you care about security, you must enable a SecurityManager:

  `-Djava.security.manager`

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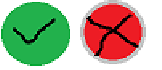
Permissions



- If you enable a SecurityManager, you must grant Oracle JDBC certain permissions

```
-Djava.security.policy=ojdbc.policy
```

- If you don't, JDBC will not run at all

```
[java] java.security.AccessControlException: access denied
(javax.management.MBeanTrustPermission register)
```

- Must also grant user code some permissions

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Philosophy

- No privileged access to external resources
  - Black hat cannot use JDBC to bypass permissions required to access external resources
  - User code must have `java.net.socket permission` to open a Thin driver connection
  - Cannot use Thin driver for a DoS (denial-of-service) attack
- Protect critical internal resources
  - `oracle.jdbc.OracleConnection.abort()`
- “JDBC” stand for “Java Database Access”
  - no permissions required to access the database
- The database provides database security
  - user authentication

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Default JDBC Policy File

- Default JDBC policy file is in the JDBC download

```
tar -xf demo.tar ojdbc.policy
```

- ojdbc.policy is parameterized. You must define certain system properties to use it.

```
-Doracle.jdbc.policy.JDBC_CODE_BASE=$ORACLE_HOME/lib/ojdbc8.jar
```

- Only define the system properties required by the JDBC features you use

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Best Practice

- Create your own policy file by editing ojdbc.policy
  - Delete or comment out what you don't need
- Whether to use macros or hard code paths depends on your deployment environment
  - If it is easier to redefine system properties then use the macros
  - If it is easier to edit the policy file then hard code values.
  - Editing the policy file may be marginally less secure

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ojdbc.policy file

- In order to use this policy file as is, define the following system properties:

- Grant codebase
  - `oracle.jdbc.policy.JDBC_CODE_BASE=$ORACLE_HOM/lib/ojdbc8.jar`

- SocketPermission
  - `oracle.jdbc.policy.CLIENT_HOST=client.myco.com`
  - `oracle.jdbc.policy.DBMS_HOST=db.myco.com`
  - `oracle.jdbc.policy.DBMS_PORT=1521`

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ojdbc.policy file

- Always needed PropertyPermissions
  - permission `java.util.PropertyPermission "user.name", "read";`
  - permission `java.util.PropertyPermission "oracle.jdbc.*", "read";`
  - permission `java.util.PropertyPermission "oracle.net.*", "read";`
  - permission `java.util.PropertyPermission "javax.net.ssl.*", "read";`

- Needed RuntimePermission for OCI driver
  - permission `java.lang.RuntimePermission "loadLibrary.ocijdbc12";`

- Needed only if you need orai18n.jar for NLS
  - permission `java.io.FilePermission "${oracle.jdbc.policy.ORAI18N}", "read";`

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ojdbc.policy file

- Needed only if you use Fast Connection Failover
  - permission `oracle.ons.CreatePermission "ONSUser";`
  - permission `oracle.ons.SubscribePermission "ONSUser";`
  - permission `java.io.FilePermission "${oracle.jdbc.policy.OPMN_CONFIG}", "read";`
  - permission `java.util.PropertyPermission "oracle.ons.*", "read";`

- Remote ONS host:port
  - permission `java.net.SocketPermission "${oracle.jdbc.policy.REMOTE_ONS_HOST1}:${oracle.jdbc.policy.REMOTE_ONS_PORT1}", "connect,resolve";`
  - permission `java.netSocketPermission "localhost", "connect,resolve";`

- Many permissions based on feature in use such as DMS, XA, XDB, AQ, NLS etc.

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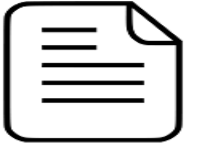
ojdbc.policy



```
/*  Copyright Oracle 2007, 2017
  In order to use this policy file as is, define the following system properties

  -Doracle.jdbc.policy.CLIENT_HOST=client.myco.com
  -Doracle.jdbc.policy.DBMS_HOST=db.myco.com
  -Doracle.jdbc.policy.DBMS_PORT=1521
  -Doracle.jdbc.policy.DMS_CODE_BASE=$ORACLE_HOME/lib/dms.jar

  -Doracle.jdbc.policy.JDBC_CODE_BASE=$ORACLE_HOME/lib/ojdbc??.jar for the jar used

  -Doracle.jdbc.policy.ORAI18N=$ORACLE_HOME/lib/orai18n.jar
  -Doracle.jdbc.policy.USER_CODE_BASE=/home/myapp/lib/-
  -Doracle.jdbc.policy.ONS_CODE_BASE=$ORACLE_HOME/opmn/lib/ons.jar
  -Doracle.jdbc.policy.CONNECTION_POOL_CODE_BASE=myConnectionPool.jar
  -Doracle.jdbc.policy.OPMN_CONFIG=$ORACLE_HOME/opmn/conf/*
  -Doracle.jdbc.policy.REMOTE_ONS_HOST1=db.myco.com
  -Doracle.jdbc.policy.REMOTE_ONS_PORT1=4200

  Of course you can also edit this file and replace the macros (stuff enclosed in ${foo} )
  with the actual values. You can add multiple SocketPermissions to support multiple hosts
  and clients for the Thin driver or you can use wildcards (*). If you don't use DMS you don't
  need to define the DMS system properties.
*/

grant codeBase "file:${oracle.jdbc.policy.JDBC_CODE_BASE}" {
```

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Performance

- May be small performance penalty
- It only applies when application attempts some activity that requires permission checks.
- Most operations that requires permission checks are expensive operations (IO, Network access etc.), so overhead of security checks will be pretty low percentage of total runtime.
- Benchmark your application

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Resources

- Policy Syntax File:
  - http://docs.oracle.com/javase/8/docs/technotes/guides/security/PolicyFiles.html#FileSyntax
- Permissions in JDK:
  - http://docs.oracle.com/javase/8/docs/technotes/guides/security/permissions.html
- JDBC Download:
  - http://www.oracle.com/technetwork/database/features/jdbc/jdbc-ucp-122-3110062.html

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Q&A

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