Management and Monitoring

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About me

- Senior Quality Assurance Engineer, JBoss by Red Hat
- With company since February 2010
- Experience with JBoss AS since 2005

- Main focus: JBossWS CXF stack, performance testing, AS7+8 / EAP6 model, Maven

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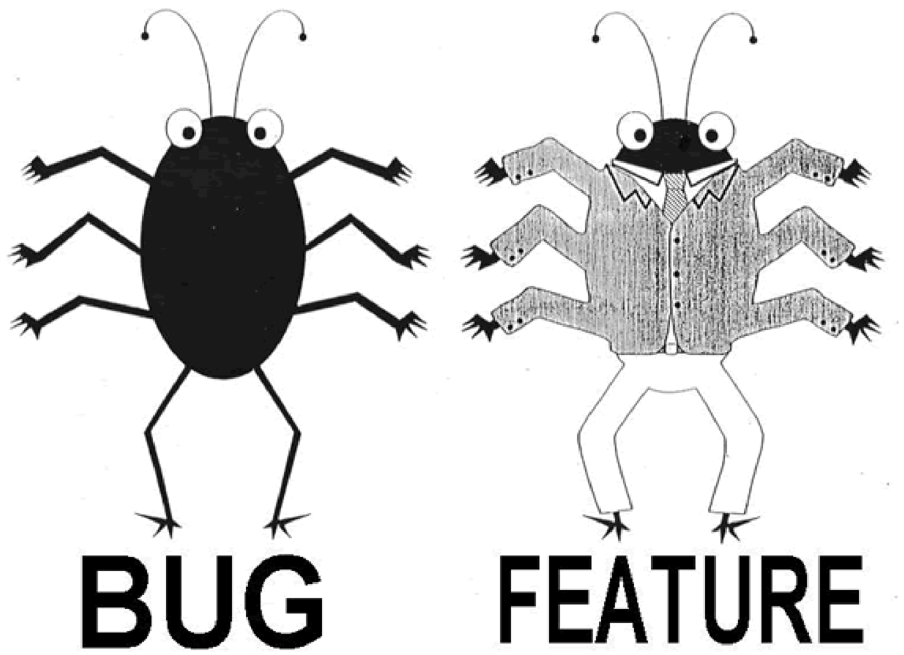
Agenda

- Monitoring
  - JDK tools
  - System tools
  - AS7 specifics
- AS7 goals, architecture
- AS7 Domain Model
- AS7 Management
  - CLI / Scripting + Java API + HTTP API
  - WebUI + RHQ / JON

Monitoring – motivation

"It's Not A Bug, It's A Feature!"



We will learn how to do some basic investigation and JVM monitoring.

JDK tools - JAR level investigation

jar tf $file or unzip -l $file

```
jar tf jboss-modules.jar
```

javap -classpath $file FQCN

```
javap -classpath jboss-modules.jar org.jboss.modules.JarModuleLoader
javap -private -classpath jboss-modules.jar org.jboss.modules.JarModuleLoader
```

javap -c -classpath $file FQCN

```
javap -c -classpath jboss-modules.jar org.jboss.modules.JarModuleLoader
```

bytecode disassembled into the bytecode instructions defined by the JVM specification

JDK tools – info about process

jps -l [-m -v]

- JDK specific

jcmd [-l -f]

- JDK 7+
- jcmd $PID <command> ... start with 'help' command

jinfo $PID

- Java system properties + VM flags

JDK tools – info about memory

```
jmap $PID
```

```
jmap -heap $PID
```

java heap summary

```
jmap -dump:file=heap-dump $PID
```

dump java heap in hprof binary format

```
jhat heap-dump
```

Check http://127.0.0.1:7000/

JDK tools – stack trace and JVM stats

```
jstack -l $PID
```
stack traces of Java threads for a given Java process, thread locking issues

```
kill -QUIT $PID or Ctrl + \
```
detail in java process console - same as jstack + heap details

```
jstat -gcutil -t $PID 1s 30
```
summary of GC statistics, 30 snapshots, each second one generated

```
jstat -class $PID
```
Class loader statistics

JDK tools – GUI

jconsole $PID

- Heap and Non-Heap memory usage, CPU usage, VM summary
- number of threads and classes, stack trace for each thread
- MBeans details

jvisualvm

- nicer look & feel, based on NetBeans platform
- Heap and PermGen memory usage, CPU usage, VM summary
- number of threads and classes, details for each thread, not stack trace
- lightweight CPU and memory profiling + sampling

System tools – OS, CPU

OS

Linux	uname -a, cat /etc/redhat-release
Solaris	uname -a
Windows	hostname, ver

CPU

Linux	top, htop, cat /proc/cpuinfo,
Solaris	top,
Windows	Ctrl+Alt+Delete --- Task Manager

System tools – memory, disk

Memory

Linux	free, vmstat -a
Solaris	vmstat, vmstat 3
Windows	Ctrl+Alt+Delete --- Task Manager

Disk

Linux	df -h, du -h
Solaris	df -h, du -h
Windows	Ctrl+Alt+Delete --- Task Manager --- advanced monitoring

System tools – processes, ports

Processes

Linux	ps aux, top, kill -9
Solaris	ps -adef, pargs, pfiles, kill -9
Windows	Ctrl+Alt+Delete --- Task Manager, taskkill /F /T /PID %PID%
	WMIC PROCESS get Caption,Commandline,Processid

Ports

Linux	netstat -natup, tcpdump
Solaris	netstat -an
Windows	netstat -a -n

AS7 specifics

JDR - JBoss Diagnostic Reporter

bin/jdr.sh [.bat]

JBoss specific tool for diagnostic

add at least one user into ManagementRealm using bin/add-user.sh

jconsole

bin/jconsole.sh [.bat]

Management of JBoss AS7 is exposed over a native interface build on top of JBoss Remoting, also JSR-160 connector is provided to make JMX remotely accessible.

Advanced tools

- your IDE debugger
- your IDE profiler
- JProfiler - http://www.ej-technologies.com/products/jprofiler/overview.html
- Java Decompiler - http://java.decompiler.free.fr/
- TDA - Thread Dump Analyzer - http://java.net/projects/tda/
- MAT - Memory Analyzer - http://www.eclipse.org/mat/

- Sysinternals tools - - http://technet.microsoft.com/en-us/sysinternals/bb842062
- Wireshark - http://www.wireshark.org/

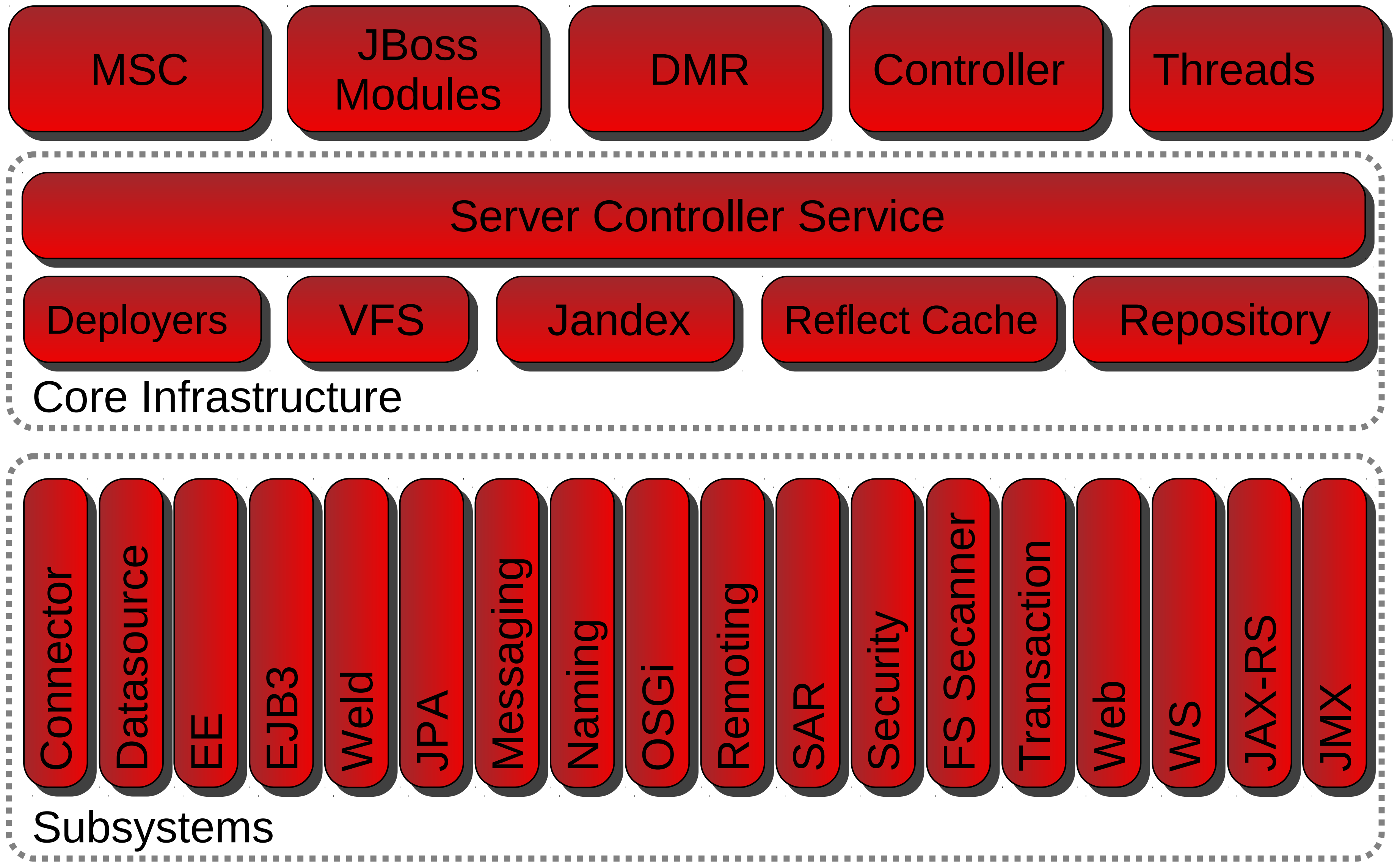
AS7 motivation aka look at the mirror

- Legacy subsystems
- Boot time
- Memory footprint
- Testability
- Modularity
- Administration options
- Not “good enough”

AS7 goals and features

- Make it smaller and faster
- Remove legacy stuff
- Remove unnecessary abstraction layers
- Improve manageability
- Multi-node management
- Simplify configuration
- Modularize

AS7 Architecture



MSC - Modular Service Container

- https://github.com/jbossas/jboss-msc

- Replacing the JBossAS 5 & 6 microcontainer
- Small and lightweight
- Everything is a service
- Services have only two states Up & Down
- Additional lifecycle states modeled using additional services
- New algorithms for checking module/service dependencies at deploy and run time
- Only the services you need are loaded and started
- Services are unloaded when not needed

MSC - Modular Service Container – verbose

JBoss AS 7 starts and deploys all services in parallel, this complex problem is solved by new service container.

MSC is essentially an advanced concurrent and scalable state machine. It analyzes the dependencies between all services on the fly and attempts to start as many as it can at the same time, while still adhering to the relationship requirements. This means fast startup and multiple deployments in parallel.

- MSC configured to use a threadpool size of double the number of CPUs
- Annotation indexing, caching of reflection metadata
- StAX based parsing
- Lazy loading functionality
- Massive threading

JBoss Modules - Modular Classloading System

- https://github.com/jbossas/jboss-modules
- https://community.jboss.org/wiki/ModuleCompatibleClassloadingGuide
- https://docs.jboss.org/author/display/MODULES/Home
- See module.xml files in AS7 modules subdirectory

- Standalone implementation of
  - modular (non-hierarchical) class loading and
  - execution environment for Java
- No more classloader hell, scoping of classloaders more narrowly defined
- You must explicitly allow deployed services and applications to see and use dependencies
- Transitive dependencies are hidden, by default

JBoss Modules - verbose

In addition to parallel services (MSC), JBoss AS 7 also has modularity and concurrent class loading. By segmenting classes into proper modules, the app server can naturally optimize access patterns, and only look in the spot that truly owns the classes.

Also, since the visibility between modules is intentionally limited, searching is cheap. In the case of JBoss Modules, module resolution and class lookup are constant. All of this has a very high degree of concurrency, even a significant portion of class definition.

In other words, rather than a single class loader which loads all JARs into a flat class path, each library becomes a module which only links against the exact modules it depends on, and nothing more.

DMR – Dynamic Model Representation

- https://github.com/jbossas/jboss-dmr
- https://docs.jboss.org/author/display/AS71/Detyped+management+and+the+jboss-dmr+library

- Central detyped management API
- All management operations operate with/on DMR
- Compatibility is stressed
- Self describing
- Convertible from/to JSON
- Represents simple and complex types
  - int, long, big int, double, big dec, boolean, string, bytes, list, object, property, expression

DMR – Dynamic Model Representation

- org.jboss.dmr.ModelNode
  - wrapper around some value, typically some basic JDK type
  - expressions are quite interesting
- org.jboss.dmr.ModelType
  - just enum for supported types
- org.jboss.dmr.Property
  - String => ModelNode tuple

```
bsh % ModelNode node = new ModelNode();
bsh % print(node.getType());
UNDEFINED
bsh % node.set(1);
bsh % print(node.getType());
INT
```

```
bsh % node.set(true);
bsh % print(node.getType());
BOOLEAN
bsh % node.set("Hello, world");
bsh % print(node.getType());
STRING
```

Domain model – key goals

- Self-contained, stable configuration and management API
  - End user configuration centralized in a few files
  - Configuration separated from service wiring
  - Everything in configuration schema exposed via management API
  - Schema files for all configurations
  - Stable == no incompatible changes

Domain model – key goals

- Manage multiple servers via a single control point
  - Configure a cluster
  - Start/stop nodes in a cluster
  - Rolling deployment to a cluster
  - Apply a patch to a set of servers (TBD)
- Management API exposed via:
  - Typed Java interface
  - REST
  - CLI
- Domain API is the only supported management API

Domain vs. standalone

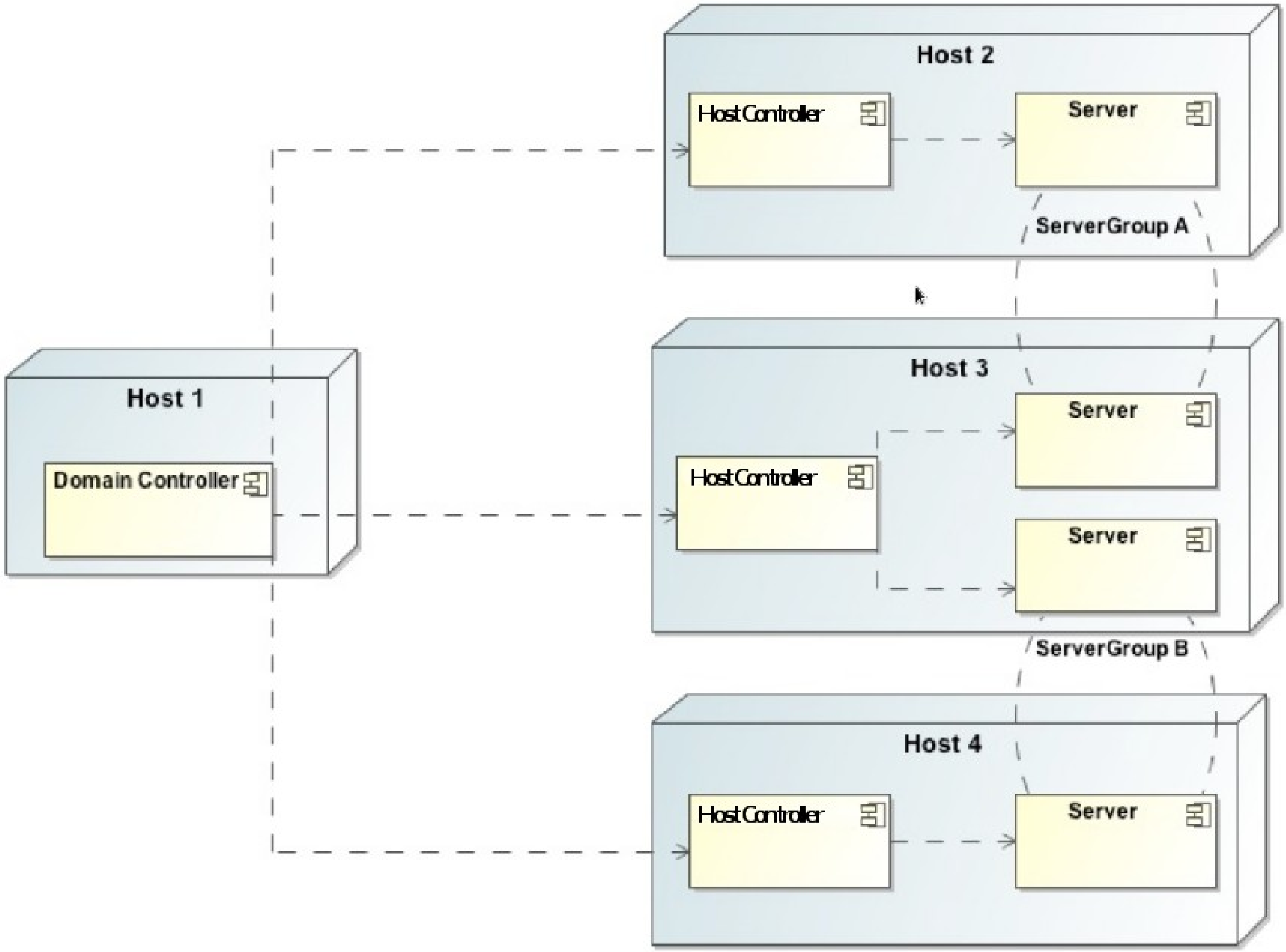
Standalone

- Traditional JBoss single JVM server
- Management facilities IN-VM
- No lifecycle management, just shutdown
- Development and embedded solutions

Domain

- Multi-JVM, multi-server model
- Lifecycle managed by Process Controller (PC)
- Management coordinated by Domain Controller (DC)
- Multiple server instances per host managed by Host Controller (HC)
- HC on master node is DC

Domain model



Domain model - terms

- https://community.jboss.org/wiki/DomainManagementModelDesign
- Domain
- Cluster
- Server
- ServerGroup
- Profile
- Subsystem
- Module

Domain model - schema

- https://community.jboss.org/wiki/JBossASDomainSchema
- docs/schema/jboss-as-config_1_2.xsd in AS7 distribution
- docs/schema/*.xsd
- standalone.xml, domain.xml, host.xml

```
<server-groups>
       <server-group name="main-server-group" profile="default">
           <jvm name="default">
               <heap size="64m" max-size="512m"/>
           </jvm>
           <socket-binding-group ref="standard-sockets"/>
       </server-group>
       <server-group name="other-server-group" profile="default">
           <jvm name="default">
               <heap size="64m" max-size="512m"/>
           </jvm>
           <socket-binding-group ref="standard-sockets"/>
       </server-group>
</server-groups>
```

```
<servers>
       <server name="server-one" group="main-server-group" auto-start="true">
           <jvm name="default"/>
       </server>
       <server name="server-two" group="main-server-group" auto-start="true">
           <jvm name="default">
               <heap size="64m" max-size="256m"/>
           </jvm>
           <socket-binding-group ref="standard-sockets" port-offset="150"/>
       </server>
       <server name="server-three" group="other-server-group" auto-start="false">
           <socket-binding-group ref="standard-sockets" port-offset="250"/>
       </server>
</servers>
```

Domain management

- End user configuration centralized in a few files
- Config changes made via management tools persisted back to the config file
- Secure remote access via:
  - Native Java interface
  - HTTP/REST + JSON
  - CLI
- All about DMR and detyped management API
  - <socket-binding name="management-native" interface="management" port="${jboss.management.native.port:9999}"/>
  - <socket-binding name="management-http" interface="management" port="${jboss.management.http.port:9990}"/>

Detyped Management API

- https://community.jboss.org/wiki/AS7DetypedManagementAPI
- https://community.jboss.org/wiki/DetypedDescriptionOfTheAS7ManagementModel
- https://community.jboss.org/wiki/FormatOfADetypedOperationRequest
- https://community.jboss.org/wiki/FormatOfADetypedOperationResponse

- The management client libraries needed to be forward compatible
- It is highly unlikely that an API that consists of hundreds of Java types could be kept forward compatible
- A detyped API works by making it possible to build up arbitrarily complex data structures using a small number of Java types

CLI

- Command line management tool for the AS 7 server
- Command bin/jboss-cli.sh or bin/jboss-cli.bat
- Interactive mode
- Non-interactive mode
- Batch mode
- GUI mode
- Operations based on model
- Generic CLI commands

CLI

```
$ ./bin/jboss-cli.sh --connect controller=IP_ADDRESS
[standalone@IP_ADDRESS:9999 /] /system-property=foo:add(value=bar)
[standalone@IP_ADDRESS:9999 /] /system-property=foo:read-resource
{
    "outcome" => "success",
    "result" => {"value" => "bar"}
}
[standalone@IP_ADDRESS:9999 /] /system-property=foo:remove
{"outcome" => "success"}
```

```
[domain@IP_ADDRESS:9999 /] /system-property=foo:add(value=bar)
[domain@IP_ADDRESS:9999 /] /system-property=foo:read-resource
[domain@IP_ADDRESS:9999 /] /system-property=foo:remove
```

```
[domain@IP_ADDRESS:9999 /] /host=master/system-property=foo:add(value=bar)
[domain@IP_ADDRESS:9999 /] /host=master/system-property=foo:read-resource
[domain@IP_ADDRESS:9999 /] /host=master/system-property=foo:remove
```

```
[domain@IP_ADDRESS:9999 /] /host=master/server-config=server-one/system-property=foo:add(value=bar)
[domain@IP_ADDRESS:9999 /] /host=master/server-config=server-one/system-property=foo:read-resource
[domain@IP_ADDRESS:9999 /] /host=master/server-config=server-one/system-property=foo:remove
```

CLI

```
/subsystem=security/security-domain=JBossTestDomainCLI:add

/subsystem=security/security-
domain=JBossTestDomainCLI/authentication=classic:add(login-
modules=[{"code"=>"UsersRoles", "flag"=>"required", "module-
options"=>[("usersProperties"=>"/home/rsvoboda/LECTURE/users.prope
rties"),
("rolesProperties"=>"/home/rsvoboda/LECTURE/roles.properties")]}])
{allow-resource-service-restart=true}

/subsystem=security/security-domain=JBossTestDomainCLI:remove
```

CLI

- https://community.jboss.org/wiki/CommandLineInterface
- https://community.jboss.org/wiki/GenericTypeCLICommands
- https://community.jboss.org/wiki/CLICompoundValueFormat
- https://community.jboss.org/wiki/CLINon-interactiveMode
- https://community.jboss.org/wiki/CLIBatchMode
- https://docs.jboss.org/author/display/AS71/CLI+Recipes

- https://community.jboss.org/wiki/JBossAS7Command-linePublicAPI

Java API

- Native management interface uses an open protocol based on the JBoss Remoting library
- The management protocol is an open protocol, so a completely custom client could be developed without using prepared libraries (e.g. using Python or some other language)

- Maven artifact org.jboss.as:jboss-as-controller-client

- https://docs.jboss.org/author/display/AS71/The+native+management+API

Java API

```
ModelControllerClient client = ModelControllerClient.Factory.
                create(InetAddress.getByName("localhost"), 9999);

ModelNode op = new ModelNode();
op.get("operation").set("read-resource");
op.get("recursive").set(true);
op.get("include-runtime").set(true);
op.get("recursive-depth").set(10);

ModelNode returnVal = client.execute(op);
System.out.println(returnVal.get("result").toString());
client.close();
```

HTTP API

- http://localhost:9990/management
- Sometimes called REST API
- HTTP request in JSON like format
- The default operation is read-resource
- add user into ManagementRealm using bin/add-user.sh

- https://docs.jboss.org/author/display/AS71/The+HTTP+management+API
- https://community.jboss.org/wiki/HTTPJSON-likeAPI

HTTP API

- GET
  - http://localhost:9990/management?recursive&include-runtime&json.pretty
  - management?operation=resource-description&recursive&operations
  - management/subsystem/web/connector/http?include-runtime&json.pretty
  - management/subsystem/web?operation=operation-names&json.pretty
- POST
  - curl --digest -L -D - http://localhost:9990/management --header "Content-Type: application/json" -d '{"operation":"read-resource","json.pretty":1}' -u ferda
  - curl --digest -L -D - http://localhost:9990/management --header "Content-Type: application/json" -d '{"operation":"read-attribute","address":[{"host":"master"},{"server":"server-one"}],"name":"server-state","json.pretty":1}' -u ferda

HTTP API

```
curl --digest -L -D - http://localhost:9990/management --header "Content-Type:
application/json" -d '{"address" : [{ "socket-binding-group" : "standard-sockets" },
{ "socket-binding" : "test" }], "operation" : "add", "port" : 8181, "json.pretty":1}' -u
ferda
```

```
curl --digest -L -D - http://localhost:9990/management --header "Content-Type:
application/json" -d '{"address" : [{ "subsystem" : "web" },{ "connector" : "test-
connector" }], "operation" : "add", "socket-binding" : "test", "scheme" : "http",
"protocol" : "HTTP/1.1", "enabled" : true, "json.pretty":1}' -u ferda
```

```
curl --digest -L -D - http://localhost:9990/management --header "Content-Type:
application/json" -d '{"address" : [{ "subsystem" : "web" },{ "connector" : "test-
connector" }], "operation" : "remove", "json.pretty":1}' -u ferda
```

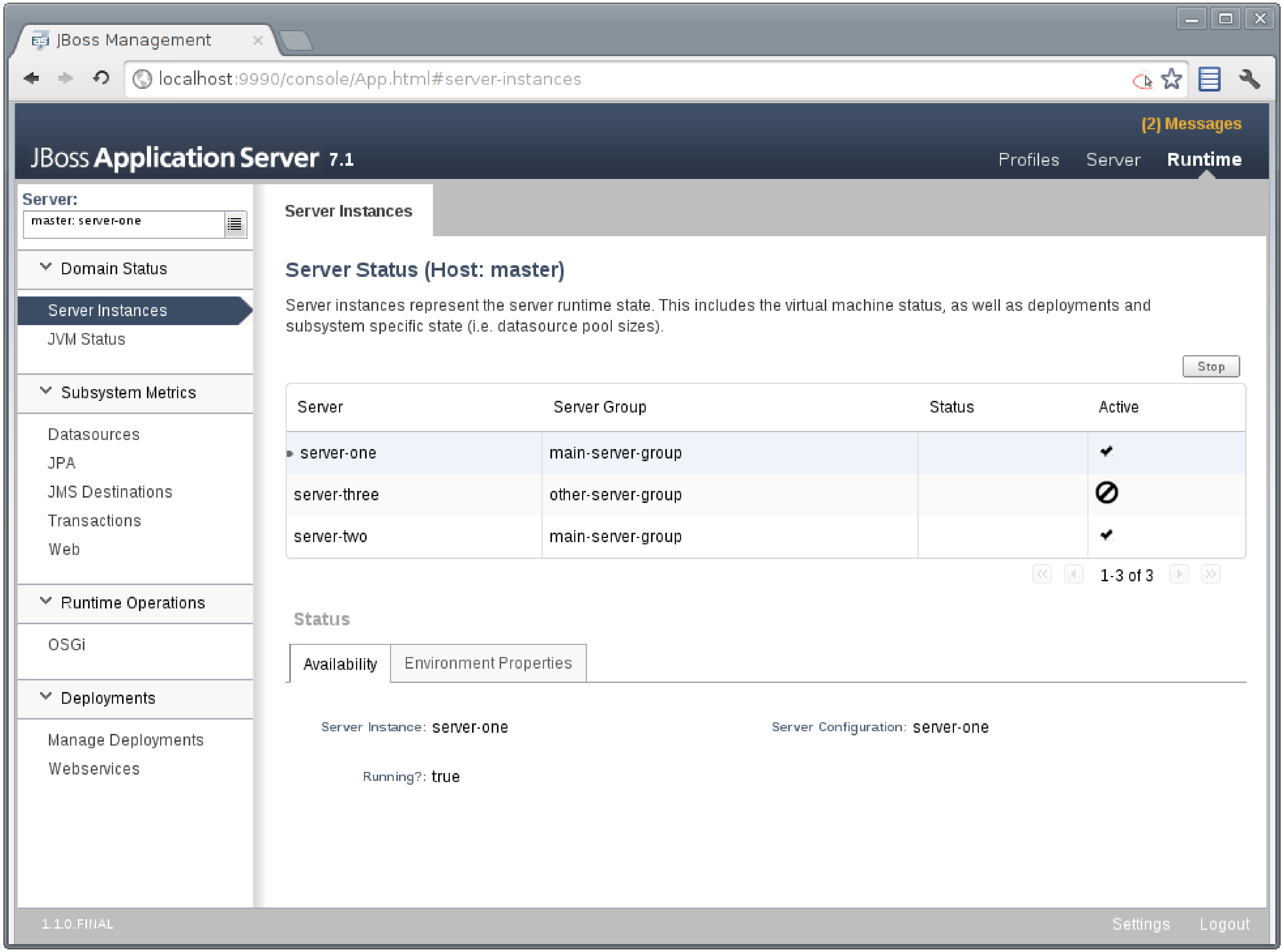
```
curl --digest -L -D - http://localhost:9990/management --header "Content-Type:
application/json" -d '{"address" : [{ "socket-binding-group" : "standard-sockets" },
{ "socket-binding" : "test" }], "operation" : "remove", "json.pretty":1}' -u ferda
```

HTTP API

```
curl --digest -u ferda:mravenec -L -D - http://localhost:9990/management --header "Content-Type: application/json"
-d '{
"address" : [{ "subsystem" : "security" }, { "security-domain" : "JBossTestDomainHTTP" }],
"operation" : "add",
"cache-type" : "default",
"json.pretty":1
}'
curl --digest -u ferda:mravenec -L -D - http://localhost:9990/management --header "Content-Type: application/json"
-d '{
"address" : [{ "subsystem" : "security" }, { "security-domain" : "JBossTestDomainHTTP" }, { "authentication" :
"classic" }],
"operation" : "add",
"login-modules" : [{"code":"UsersRoles", "flag":"required", "module-options":{"usersProperties" :
"/home/rsvoboda/LECTURE/users.properties", "rolesProperties" : "/home/rsvoboda/LECTURE/roles.properties"} }],
"json.pretty":1
}'

curl --digest -u ferda:mravenec -L -D - http://localhost:9990/management --header "Content-Type: application/json"
-d '{
"address" : [{ "subsystem" : "security" }, { "security-domain" : "JBossTestDomainHTTP" }],
"operation" : "remove",
"json.pretty":1
}'
```

Web console



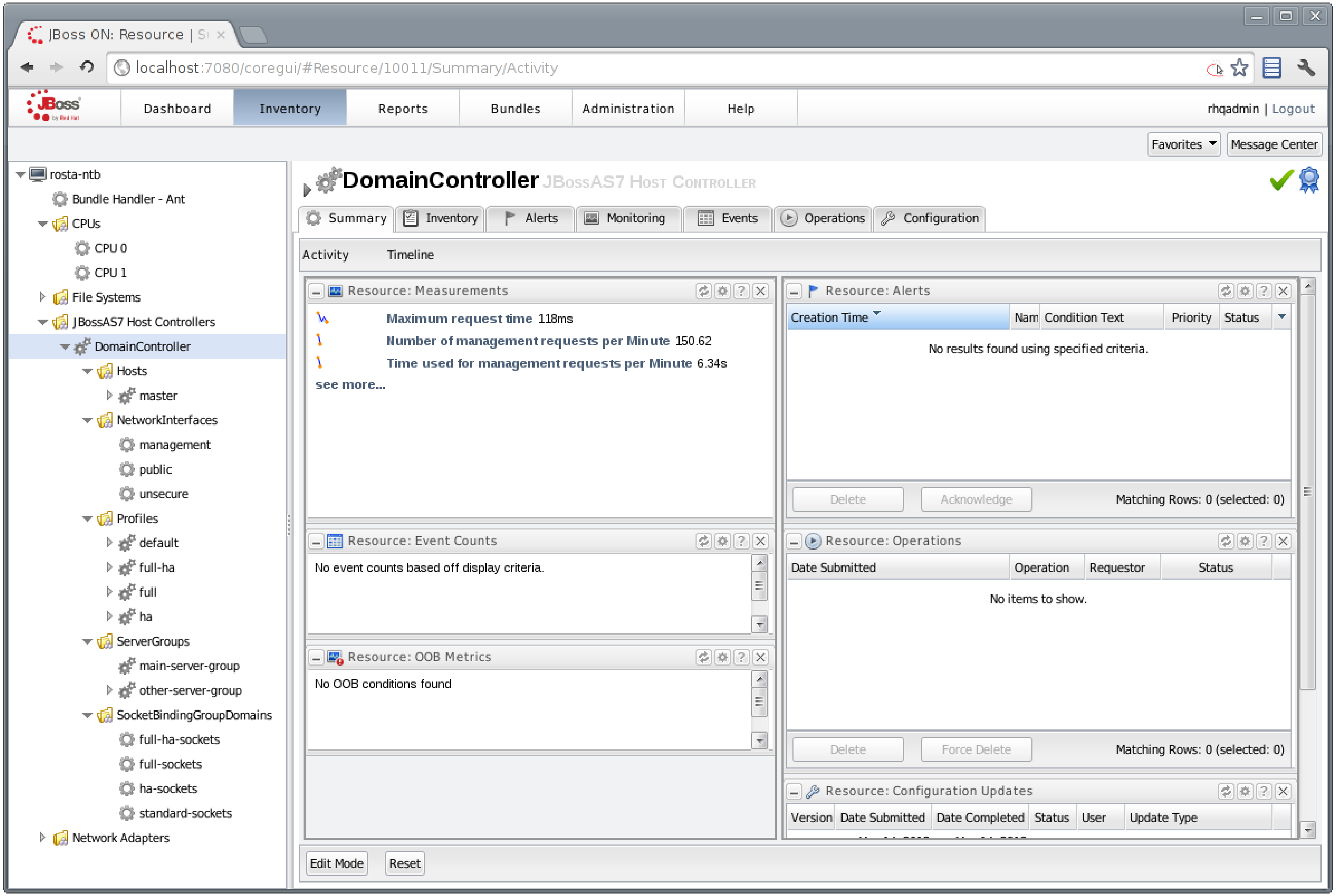
Server Status (Host: master)

Server instances represent the server runtime state. This includes the virtual machine status, as well as deployments and subsystem specific state (i.e. datasource pool sizes).

Server	Server Group	Status	Active
server-one	main-server-group		✓
server-three	other-server-group		⊘
server-two	main-server-group		✓

Server Instance: server-one
Server Configuration: server-one
Running?: true

RHQ / JON



JBoss ON: Resource | S

localhost:7080/coregui/#Resource/10011/Summary/Activity

Dashboard | Inventory | Reports | Bundles | Administration | Help

rhqadmin | Logout

Favorites | Message Center

- rosta-ntb
  - Bundle Handler - Ant
  - CPUs
    - CPU 0
    - CPU 1
  - File Systems
  - JBossAS7 Host Controllers
    - DomainController
      - Hosts
        - master
      - NetworkInterfaces
        - management
        - public
        - unsecure
      - Profiles
        - default
        - full-ha
        - full
        - ha
      - ServerGroups
        - main-server-group
        - other-server-group
      - SocketBindingGroupDomains
        - full-ha-sockets
        - full-sockets
        - ha-sockets
        - standard-sockets
  - Network Adapters

DomainController JBossAS7 Host Controller

Summary | Inventory | Alerts | Monitoring | Events | Operations | Configuration

Activity | Timeline

Resource: Measurements

Maximum request time	118ms
Number of management requests per Minute	150.62
Time used for management requests per Minute	6.34s

see more...

Resource: Alerts

Creation Time	Nam	Condition Text	Priority	Status

No results found using specified criteria.

Delete | Acknowledge | Matching Rows: 0 (selected: 0)

Resource: Event Counts

No event counts based off display criteria.

Resource: OOB Metrics

No OOB conditions found

Resource: Operations

Date Submitted	Operation	Requestor	Status

No items to show.

Delete | Force Delete | Matching Rows: 0 (selected: 0)

Resource: Configuration Updates

Version	Date Submitted	Date Completed	Status	User	Update Type

Edit Mode | Reset

That's all ...