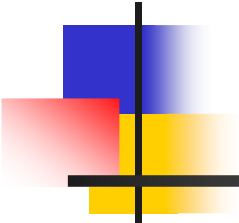
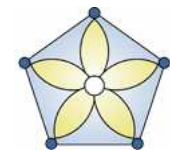
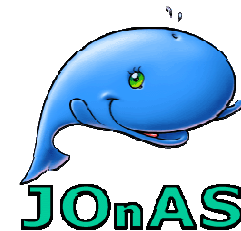


BundleMonitor: Bundle Resource Cost Monitoring on OSGi based Application Server



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Agenda

- Motivation
- Challenge
- Design & Implementation
- Case Study
- Conclusion



Motivation

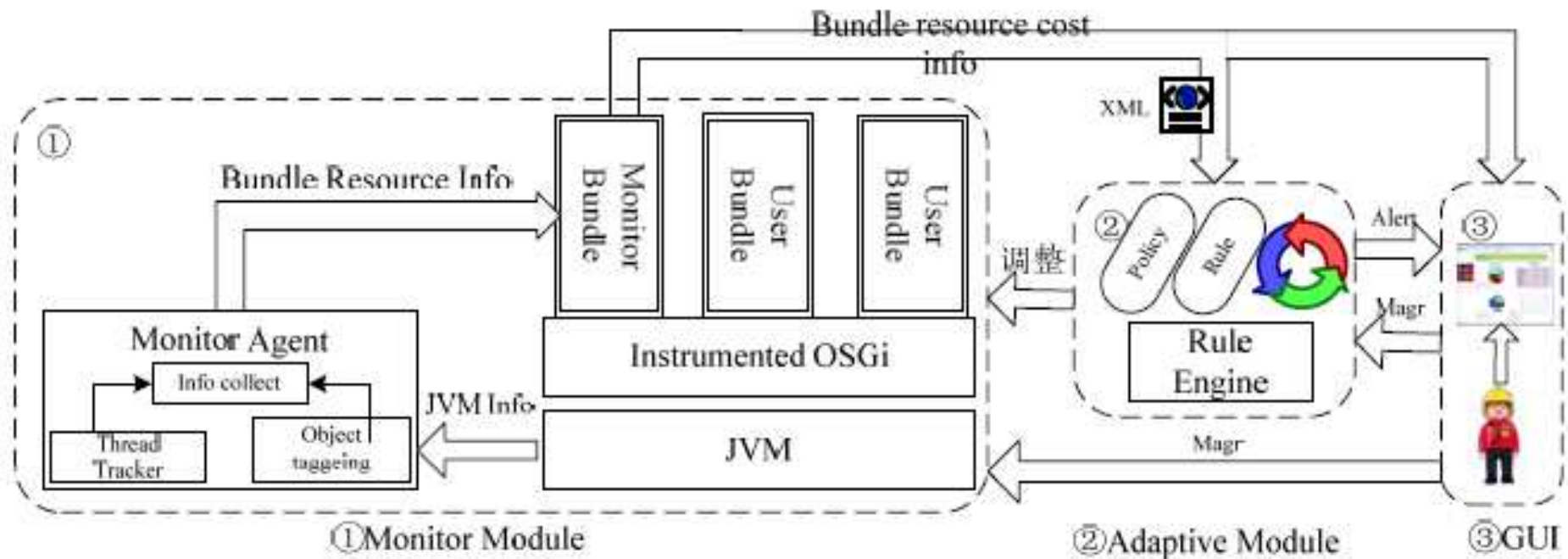
- OSGi is a component-oriented computing environment and applied widely
 - Eclipse
 - JOnAS, PKUAS, JBoss, Spring dm, Webshpere, Weblogic
- Measure the resource cost of each bundle of OSGi platform and applications could help
 - Diagnose the questionable bundle
 - Provide criteria for selection of homogeneous bundle



Challenge

- OSGi platform and applications run in a JVM and share common memory and CPU
 - CPU is always cost by java thread way
 - Memory is always cost by java object way
 - How to distribute the resources between service consumer and service provider?
- Challenge
 - Mapping from bundles to threads and java objects
 - Distribute the service provider and consumer's resource cost clearly
 - Accurately monitor the CPU and memory cost

Design & Implementation



Association of bundle and java objects

- Modify the class image at the time of class loading
 - JVM TI *ClassFileLoadHook*
 - Add *new_obj()* at the entry of init method of `java.lang.Object`
 - Add *new_array()* method behind the `newarray` bytecode

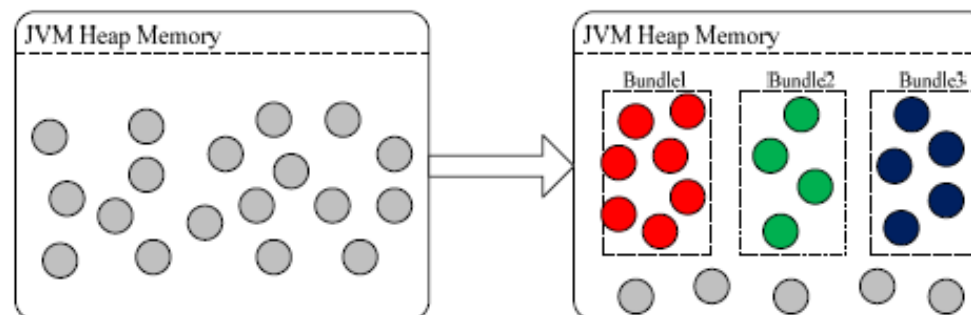


Fig.2 Object tagging

Association of bundle and threads

- Thread in a single bundle
 - *ThreadLocal* to create association
- Thread in a several bundles
 - Partition the thread's CPU time into different bundles

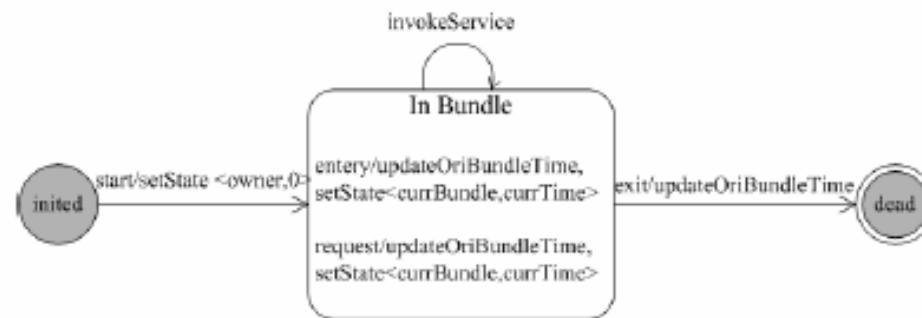
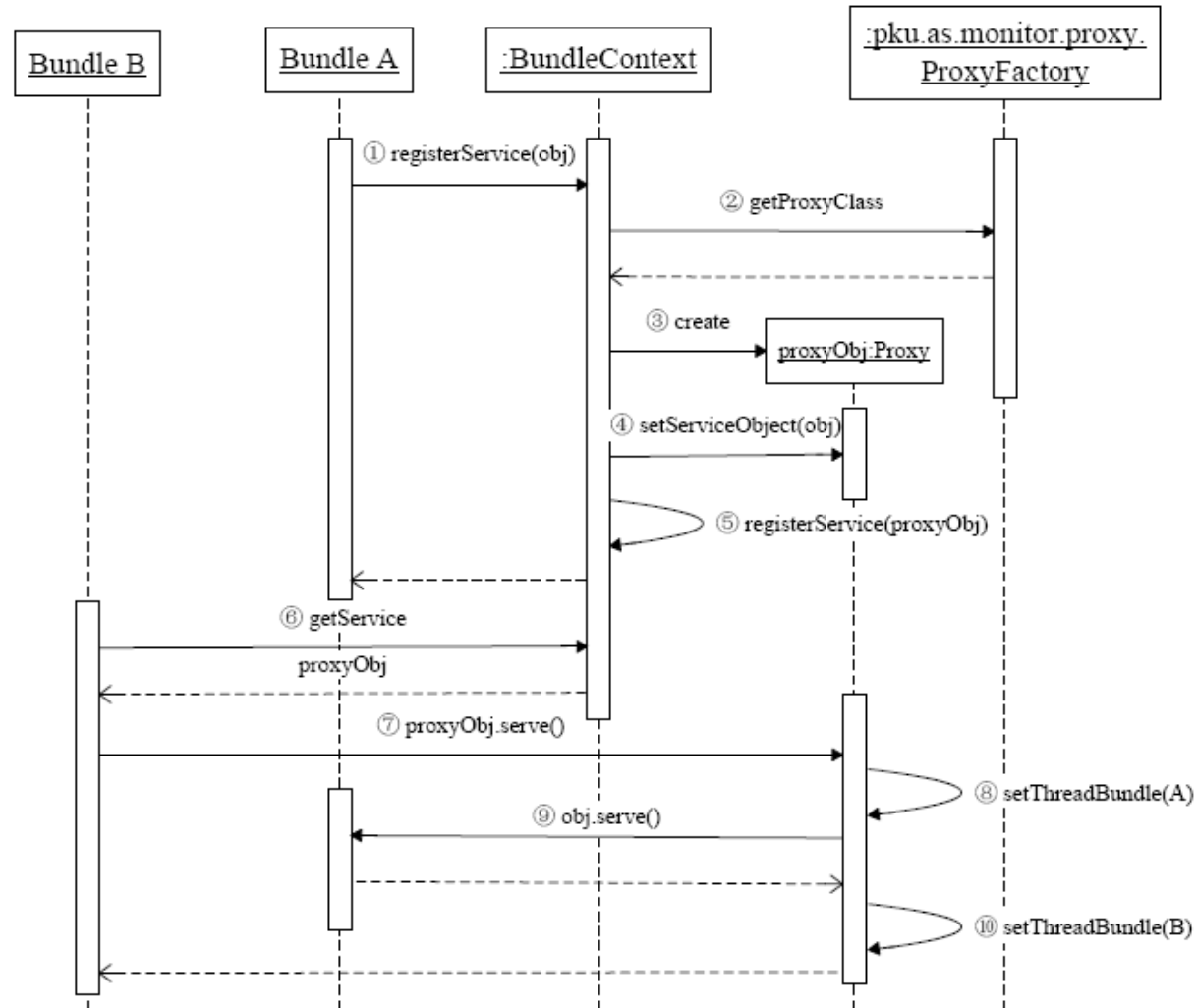


Fig.3 Thread state diagram in bundle context switch

Clearly resource cost distribution





Case Study

- Apache Felix
 - Felix is a community effort to implement the OSGi R4 Service Platform, which includes the OSGi framework and standard services, as well as providing and supporting other interesting OSGi-related technologies.
- JOnAS 5
 - JOnAS 5, the new generation dynamic application platform from OW2, provides many innovative features to Java EETM platform administrators, operators and developers.

Apache Felix → Performance Overhead

Table 1 Time and memory cost contrasts of OSGi platform at startup

	Original Felix		Instrumented Felix	
	Average startup time	Average memory cost	Average startup time	Average memory cost
Without application loading	212.4ms	10,661KB	596.8ms	11,988KB
Loading several applications	421.5ms	11,649KB	1781ms	13,742KB

Table 2 Service registration time contrasts

service interfaces	1	2	3	4	5	6	7	8	9	10
Original (ms)	-	-	-	-	-	-	-	-	-	-
Instrumented (ms)	16	40.6	62.6	78.2	112.2	137.6	162.4	203	243.6	297

Table 3 Service invocation time contrasts

10 ⁵ invocation	1	2	3	4	5	6	7	8	9	10
Original (ms)	1818.6	3621.8	5440.8	7259.4	9215.4	11010	12949.8	14675	16356.2	18537.4
Instrumented (ms)	15.2	15.4	16	15.2	28.6	27.8	37.4	37.6	43.6	47
Overhead (ms)	1803.4	3606.4	5424.8	7244.2	9186.8	10982	12912.4	14637	16312.6	18490.4

One service invocation overhead is **0.018ms**



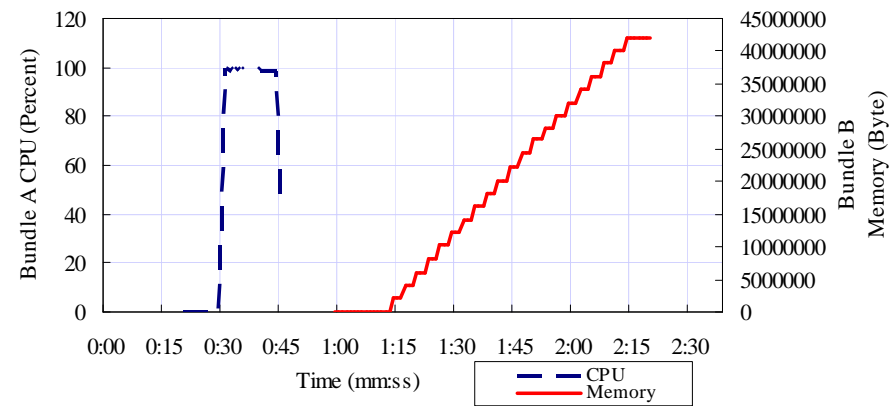
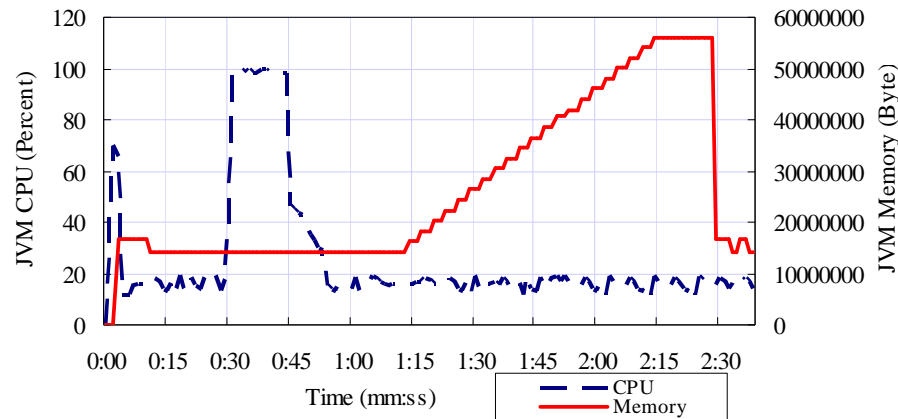
Apache Felix → Accuracy

- Two intended bundle is designed to cost certain memory and cpu
- Bundle A provide a service which deadly loops for 1 second and stops. So it cost 1s cpu.
- Bundle B creates i integer arrays at stage i , which includes 10^5 integers and call service A i times. So it cost $4i \times 10^5$ B memory and i second CPU.

Table 4 The accuracy of monitoring

stage	1	2	3	4	5	6	7	8	9	10
CPU EXP	1	3	6	10	15	21	28	36	45	55
CPU MEA	1.05	3.0375	5.96875	9.99375	15.04317	20.89063	27.825	35.76563	44.50625	54.15625
MEM EXP	400000	1200000	2400000	4000000	6000000	8400000	11200000	14400000	18000000	22000000
MEM MEA	400008	1200024	2400040	4000056	6000072	8400088	11200104	14400120	18000136	22000152

Apache Felix → Adaptability



Apache

面向OSGI平台的构件资源监控工具 - Mozilla Firefox

file:///D:/workspace/lib/

Bundle Monitor is a profile tool facing to the OSGI platform. It can detect and present the resource each bundle costs in detail.

- Home
- Bundle
- CPU
- Memory
- Rule

name
system
system_bundle
org.apache.felix.shell
org.apache.felix.shell
org.apache.felix.bund
pkuas.chart
MonitorBundle
total

完成

面向OSGI平台的构件资源监控工具 - Mozilla Firefox

file:///D:/workspace/lib/felix/BundleMonitor.html

Bundle Monitor is a profile tool facing to the OSGI platform. It can detect and present the resource each bundle costs in detail.

- Home
- Bundle
- Memory Pie Chart
- Memory Line Chart

完成

面向OSGI平台的构件资源监控工具 - Mozilla Firefox

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- CPU Pie Chart
- CPU Line Chart
- CPU Diff Pie Chart
- CPU Diff Line Chart

CPU Chart

完成

JOnAS 5

Bundle Monitor is a profile tool facing to the OSGi platform. It can detect and present the resource each bundle costs in detail.

- Home
- Bundle
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- Rule

name	cpu (毫秒)	memory (字节)
system	1216807	1555720
system.bundle	1762811	203280
org.apache.felix.shell	15600	11504
org.apache.felix.bundlerepository	15600	1408
org.apache.felix.ipopo	1279208	2037484
org.ow2.bundles.ow2-util-ee-deploy-impl	1279208	440816
org.ow2.bundles.ow2-util-scan-impl	2589516	1328
org.apache.felix.ipopo.arch	0	1424
org.ow2.bundles.ow2-util-ee-metadata-war-impl	1419609	11264
org.ow2.bundles.ow2-util-log	0	1400
org.ow2.bundles.util-plan-schemas	0	706
org.ow2.bundles.util-plan-fetcher-impl	15600	1544
org.ow2.bundles.util-plan-fetcher-impl-url	0	936
org.ow2.bundles.util-plan-fetcher-impl-maven2	0	4536
org.ow2.bundles.util-plan-fetcher-impl-obr	0	704
org.ow2.bundles.util-plan-deploy-impl	62400	67984
org.ow2.bundles.util-plan-repository-impl	0	632
org.ow2.bundles.util-plan-monitor	0	1456
org.ow2.bundles.util-plan-reader	795605	588984
org.ow2.bundles.util-plan-deployer	140400	78184
org.ow2.jonas.osgi.javaee-api	62400	1408

Bundle Monitor is a profile tool facing to the OSGi platform. It can detect and present the resource each bundle costs in detail.

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- Rule

CPU Pie Chart CPU Line Chart
CPU Diff Pie Chart CPU Diff Line Chart

Bundle Monitor is a profile tool facing to the OSGi platform. It can detect and present the resource each bundle costs in detail.

- Home
- Bundle
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- Rule

Memory Pie Chart Memory Line Chart



Conclusion

- Monitor the bundle resource cost for OSGi platform and applications
- Applied in Apache Felix and JOnAS 5
- It could correctly monitor the cost with little performance overhead and bring adaptability.
- Rich client interface support



Future work

- Publish the rich client interface as *Http Service*
- Improve the rich client interface
- Evaluate the CPU and memory cost of each common service
 - Establish the relation between common service and bundles.



Thanks for your attention😊

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