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Apache Tomcat

Tomcat Clustering: Part 1 – Reverse Proxies

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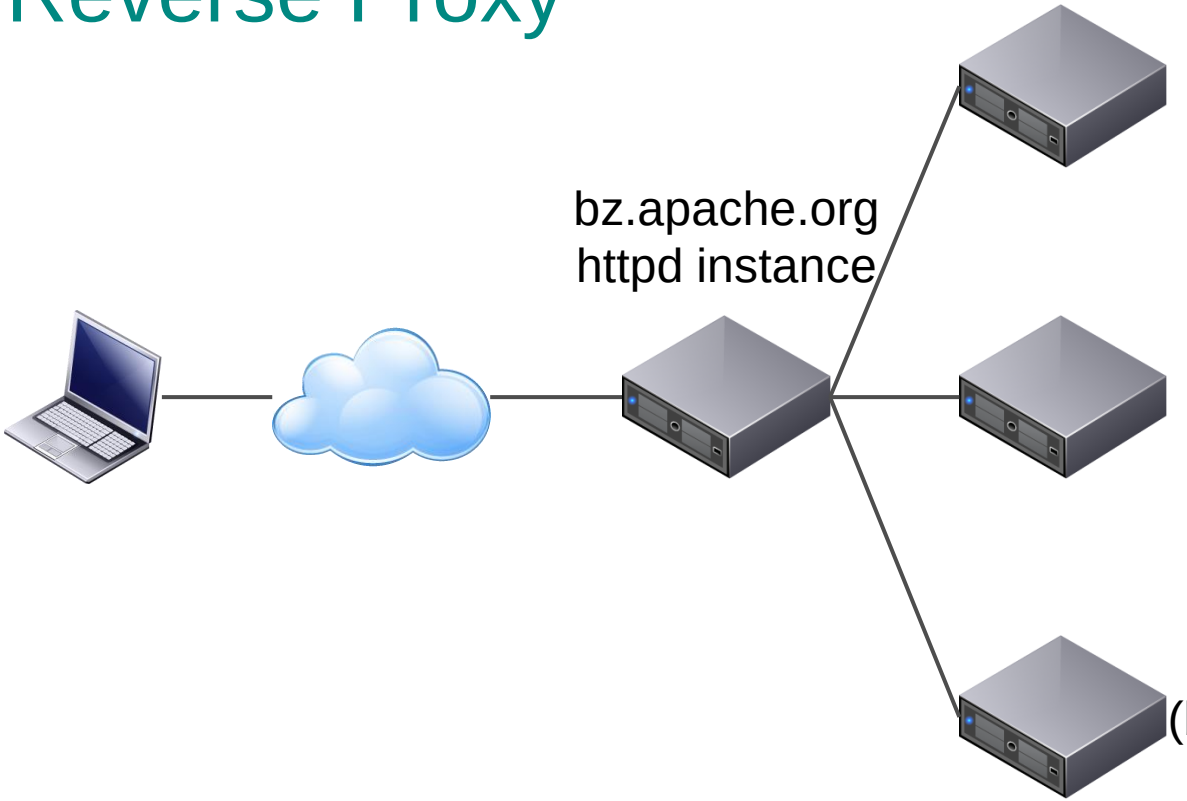
Introduction

- Apache Tomcat committer since December 2003
  - markt@apache.org
- Tomcat 8 release manager
- Member of the Servlet, WebSocket and EL expert groups
- Consultant Software Engineer @ Pivotal
- Currently focused on Apache Tomcat 9

Terminology

Reverse Proxy



Bugzilla (Main)
(bz.apache.org/bugzilla)
httpd instance

Bugzilla (AOO)
(bz.apache.org/ooo)
httpd instance

Bugzilla (SpamAassassin)
(bz.apache.org/SpamAssassin)
httpd instance

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Reverse Proxy

- Looks like a single host to the clients
- Usually multiple hosts
- Different services on different hosts
  - May also be geographically distributed
- Can be used to add features
  - e.g. Use httpd as a reverse proxy for Tomcat to add Windows authentication (no longer necessary)

Reverse Proxies

Agenda

- Protocol selection
- httpd module selection
- Tomcat connector implementation selection
- Troubleshooting
- Questions

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Protocol Selection

- Two options
  - AJP
  - HTTP
- Best choice depends on circumstances
  - No clear winner
- Both support persistent connections
  - On a fast LAN or the same machine this makes little difference

Protocol Selection

AJP

- Not a binary protocol
  - Common headers and values encoded
  - Other values in plain text
  - Request and response bodies in plain text
- Request headers must fit in a single AJP message
  - Default 8192
  - Max 65536

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Protocol Selection

AJP

- Supports passing of SSL termination information
- Does not directly support encryption
  - IPSec, VPN, SSH tunnel, etc.
- Supports ping to validate connection status

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Protocol Selection

HTTP

- Clear text protocol
  - Easy to read
- No limit on request header size
- No dedicated ping

Protocol Selection

HTTP

- Does not directly support providing SSL termination information
  - Can be added by httpd using custom headers
  - Can be processed by Tomcat using the SSLValve

- Supports encryption via HTTPS

Protocol Selection

AJP vs. HTTP

- If terminating SSL at httpd and you need SSL the information
  - Use AJP
- If you need to encrypt the httpd to Tomcat channel
  - Use HTTP

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Protocol Selection

AJP vs. HTTP

- If you need both
  - Use HTTP
  - It is (usually) easier to pass SSL information over HTTP than it is to encrypt AJP
- If you need neither
  - Pick the one you are more familiar with – debugging problems will be easier

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httpd Module Selection

- Avoid
  - mod_jk2
  - mod_jserv
  - mod_webapp
  - anything else not explicitly mention below
- Consider
  - mod_jk
  - mod_proxy
  - (mod_rewrite)

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httpd Module Selection

mod_rewrite

- You can replace most of httpd.conf with mod_rewrite directives
- That doesn’t mean that you should
- It is generally more efficient to use the dedicated directive
- There are times (complex load balancing rules) where I’ve used mod_rewrite

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httpd Module Selection

mod_rewrite

- mod_jk and mod_proxy can route based on environment variables
- Use mod_rewrite and/or mod_setenvif to determine the routing info
- Set the routing configuration with mod_jk / mod_proxy

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httpd Module Selection

mod_jk

- Only supports AJP
- Developed by the Tomcat committers
  - More frequent releases than httpd
  - Features developed in mod_jk first
- Non-httpd style configuration
- More complex URL mappings are simpler to write
- Binaries only provided for Windows

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httpd Module Selection

mod_jk

- Doesn’t directly support URL re-writing
- Make sure you are using the latest documentation
  - http://tomcat.apache.org/connectors-doc/
- The status worker can be used for monitoring and management

httpd Module Selection

mod_proxy

- Supports AJP and HTTP
- Included as standard with httpd
- Uses httpd style configuration
- More complex URL mappings are trickier to write
- Built-in support for URL re-writing (not all use cases)
- Binaries provided for most platforms

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httpd Module Selection

mod_jk vs/mod_proxy

- If you need the latest features
  - mod_jk
- If you have complex mapping rules
  - Consider mod_jk
- Not on Windows and don't want to have to compile the module
  - mod_proxy

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httpd Module Selection

mod_jk vs mod_proxy

- If you will be load-balancing
  - mod_jk's management interface is probably better
- Already using one of these
  - Carry on
  - The costs of changing will probably out-weight the benefits
- If you have a free choice
  - Use mod_proxy, the configuration style will be more familiar

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Tomcat Connector Selection

- BIO
  - Default for all version to Tomcat 8
  - Removed from Tomcat 9 onwards
  - 100% Java Blocking IO
- NIO
  - Default from Tomcat 8 onwards
  - 100% Java non-blocking IO
    - Waiting for next request
    - Reading HTTP request headers
    - SSL handshake

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Tomcat Connector Selection

- NIO2
  - Introduced in Tomcat 8
  - 100% Java non-blocking IO
    - Waiting for next request
    - Reading HTTP request headers
    - SSL handshake
- APR/native
  - Apache APR based native code with JNI providing non-blocking IO
    - Waiting for next request
    - Reading HTTP request headers (9.0.x onwards)

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Tomcat Connector Selection

- All connectors block (or simulate blocking) during
  - Request body read
  - Response body write
- SSL
  - BIO, NIO & NIO2 use JSSE
  - APR/native uses OpenSSL
  - OpenSSL is significantly faster
- Sendfile
  - NIO, NIO2 and APR/native support sendfile

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Tomcat Connector Selection

- Comet
  - Has been removed for Tomcat 9
  - NIO, NIO2 and APR/native support Comet
- WebSocket
  - All connectors support WebSocket
  - httpd does not support WebSocket very well when acting as a reverse proxy
  - BIO fakes the non-blocking support

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Tomcat Connector Selection

BIO vs. NIO vs. NIO2 vs. APR/native

- If you use SSL
  - APR/native
- Stability
  - NIO, BIO
- Scalability
  - NIO, NIO2, APR/native

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Troubleshooting

Thread Exhaustion

- Need to understand threading models

- httpd prefork MPM
  - 1 thread per process
  - MaxRequestWorkers processes
  - Maximum of 1 * MaxRequestWorkers threads

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Troubleshooting

Thread Exhaustion

- httpd worker MPM
  - ServerLimit processes
  - ThreadsPerChild threads for each process
  - Maximum of ServerLimit * ThreadsPerChild threads

- Thread == concurrent request

Troubleshooting

Thread Exhaustion

- Each httpd thread may create a connection to each Tomcat instance
- Therefore, 2 httpd instances each with 400 threads
  - Maximum of 800 connections to each Tomcat instance
  - The connections are NOT distributed between the Tomcat instances
  - Connections are persistent by default

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Troubleshooting

Thread Exhaustion

- Connections may have low utilization
- BIO requires a thread per connection
- BIO connector may run out of threads even when Tomcat is almost idle

Troubleshooting

Thread Exhaustion: Solutions

- Use NIO connector as it is non-blocking between requests
- Don’t use persistent connections between httpd and Tomcat
- Ensure each Tomcat instance has >= threads than total httpd threads
- Configure timeouts
  - I have seen cases where httpd tried to use a timed out connection
- Use distance to create preferred groups

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Troubleshooting

Thread Exhaustion: Example

- Reverse proxy for ASF Jira had more threads than Tomcat
- Didn’t take much load for Tomcat to run out of threads
- No component was particularly loaded
- Tomcat, Java, network I/O all blamed
- 5 second fix (edit maxThreads in server.xml)
- (OK, and several minutes for Jira to restart)

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Troubleshooting

Broken Links

- Easiest way to create a lot of hassle for yourself
  - ProxyPass /foo http://localhost:10180/bar
- Easiest way to avoid the hassle
  - ProxyPass /foo http://localhost:10180/foo
- Don’t change the context path

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Troubleshooting

Broken Links

- Often marketing wants http://name.com rather than http://name.com/app
- Consider a simple redirect from / to /app
  - /app becomes visible to end users once they use the app
  - Much easier to implement and maintain
- Deploy your application as ROOT
  - Use ROOT##label if you need to add a version number or similar

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Troubleshooting

Broken Links: What can go wrong

- Redirects
  - Redirect to wrong path
- Cookie paths
  - Cookies are not returned by client
- Links
  - Created for wrong URL
- Custom headers (e.g. Spring MVC)

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Troubleshooting

Broken Links: Solutions

- Fixing redirects
  - Don’t change the context path
  - ProxyPathReverse will fix some but not all HTTP headers

- Fixing cookie paths
  - Don’t change the context path
  - ProxyPassReverseCookiePath /bar /foo

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Troubleshooting

Broken Links: Solutions

- Fixing links
  - Don’t change the context path
  - mod_sed, mod_substitute, mod_proxy_html
  - Fragile solution and a significant maintenance overhead
- Fixing custom headers
  - Don’t change the context path
  - mod_headers

Troubleshooting

Security Issues

- Need to be careful when terminating HTTPS at httpd
- Tomcat needs to know if request was received over HTTPS
  - Sessions must not transition from HTTPS to HTTP
  - Cookies created over HTTPS must be marked as secure
- mod_jk and mod_proxy_ajp just handle this
- mod_proxy_http does not

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Troubleshooting

Security Issues: Solutions

- Custom headers and the RemoteIpValve
- Two HTTP connectors
  - HTTP traffic proxied to connector with secure="false"
  - HTTPS traffic proxied to connector with secure="true"

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Troubleshooting

Miscellaneous

- Virtual host selection
  - ProxyPreserveHost on
- Client IP based security
  - RemoteIpValve

Questions

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