Server Operations Guide

BigWorld Technology 1.9.1. Released 2008.

Software designed and built in Australia by BigWorld.

Level 3, 431 Glebe Point Road
Glebe NSW 2037, Australia
www.bigworldtech.com

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Chapter 1. Introduction

BigWorld Technology is BigWorld's middleware for implementing Massively Multiplayer Online Games. This document is a guide to performing operations with the server software. It is not intended for game designers or game logic implementers, but rather for 'machine room' or 'cluster control' operators and administrators.

It is assumed that the server has been installed according to the instructions in the document Server Installation Guide. An understanding of the basic BigWorld processes is also assumed. For more details on these processes, see the document Server Overview's chapters Design Introduction and Server Components.

Note
For details on BigWorld terminology, see the document Glossary of Terms.

Chapter 2. Server Configuration with `bw.xml`

The single most important configuration file on the server is `<res>/server/bw.xml`, where `<res>` is the resource tree used by the server (usually specified in `~/.bwmachined.conf`).

All sever processes read this file. It contains many parameters, all of which are described in this chapter. The default values are appropriate for many different games, and care should be taken when changing them, since it might affect performance.

On the description of the parameters, please note the following:

- Boolean parameters should be specified as true or false.
- Where a tag is specified as *`tag1/tag2`*, the second tag is specified inside the scope of the first one. For example, the tag `dbMgr/allowEmptyDigest` is specified as:

```
<dbMgr>
  <allowEmptyDigest> true </allowEmptyDigest>
</dbMgr>
```

2.1. The entry `parentFile`

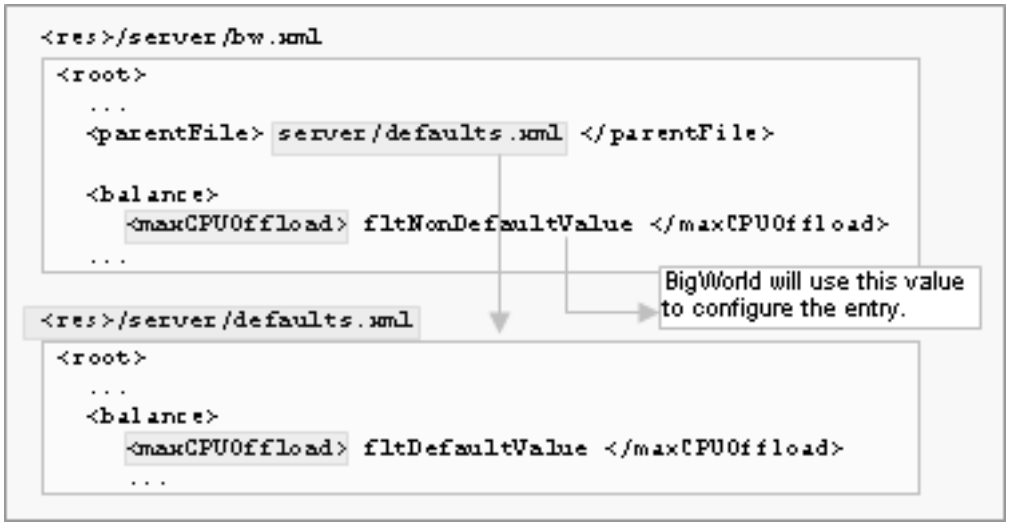
The entry `parentFile` in the configuration file specifies the next file in the chain of files where BigWorld should look for an entry for a configuration option.

To assign a default value to a configuration option, BigWorld follows the steps below:

- Searches for an entry for the configuration option in file `<res>/server/bw.xml`.
- If the file does not contain an entry for the configuration option, then the chain of configuration files is inspected, until the entry is found.
- If the entry is not specified in any of these files, a hard-coded default is used.

All default values are stored in file `bigworld/res/server/defaults.xml`. Typically, the entry `parentFile` in file `<res>/server/bw.xml` is set to `server/defaults.xml`, and only non-default options are stored in your `server/bw.xml`.

The example below shows the configuration option `maxCPUOffload` in section `balance` having its default value overridden:



2.2. User dependent configuration

A file that is user dependent can be used instead of `bw.xml`. This is useful to allow multiple users to run from the same resource tree. In a production environment, for example, you may run the resources using a test user before using the production user.

If a file with the name `server/bw_<username>.xml` exists, this is used as the start of the server configuration chain instead of `server/bw.xml`.

Typically, the `parentFile` section in this file would refer to `server/bw.xml` and only options specific to the user, such as `dbMgr/databaseName` would be in this file.

2.3. Command-Line Options

The configuration options specified in file `<res>/server/bw.xml` can also be overridden via command-line arguments.

To override a default value, add arguments in the format `+optionName` value.

The example shows the `baseApp` section's configuration option `pythonPort` having its default value changed to `40001`, and the option `archivePeriod` changed to `0`:

```
baseapp +baseApp/pythonPort 40001 +baseApp/archivePeriod 0
```

Values changed via the command line are not sent to components started via BWMachined. This includes using WebConsole, `control_cluster.py`, and components started by a Reviver process.

2.4. General Configuration Options

The list below describes the general configuration options:

- **`bitsPerSecondToClient` (Integer)**

  Desired default bandwidth from server to the client. To calculate the number of bytes to be sent in each packet, the formula below is used (where `UDP_OVERHEAD` is 28 bytes):

  ```
  packetSize = (bitsPerSecondToClient / 8 / gameUpdateHertz) - UDP_OVERHEAD
  ```

- **`debugConfigOptions` (Integer)**

  Level of logging information generated when processing configuration parameters in file `<res>/server/ bw.xml`.

  The possible values are described in the list below:

  - **0**

    No log is generated.

  - **1**

    A log message is generated for each configuration option read.

  - **2**

A verbose message is generated for each configuration option read.

- **`desiredBaseApps` (Integer)**

  Number of BaseApps that need to be running for the server to start.

- **`desiredCellApps` (Integer)**

  Number of CellApps that need to be running for the server to start.

- **`externalInterface` (String)**

  Network adapter interface to use for external communication, if not explicitly set by the server component.

  In a production environment, BaseApps are recommended to have two Ethernet adapters: one adapter connected to the Internet, and a separate one connected to the internal LAN.

  During development, there is no problem with using the same interface.

  Accepted formats are:

  - **Adapter name** - Examples: `eth0`, `eth1`
  - **IP[/netmask]** - Examples: `10.5.2.1, 10.0.0.0/8`, `192.168.5.0/24`
  - **Domain name** - Examples: `intern0.cluster/24`, `extern5.cluster/24`

  This value can be overridden by a tag with same name in the following sections:

  - `baseApp` - For more details, see “BaseApp Configuration Options” on page 15 .
  - `loginApp` - For more details, see “LoginApp Configuration Options” on page 39 .

- **`externalLatencyMax` (Float)**

  Maximum number of seconds by which packets sent from the server process will be artificially delayed. Each packet will be randomly delayed between this value and externalLatencyMin.

  This value can be overridden by a tag with the same name in the following sections:

  - `baseApp` - For more details, see “BaseApp Configuration Options” on page 15 .
  - `loginApp` - For more details, see “LoginApp Configuration Options” on page 39 .

  This feature is useful for testing during development.

  See also ??? on page 9 , ??? on page 8

- **`externalLatencyMin` (Float)**

  Minimum number of seconds by which packets sent from the server process will be artificially delayed. Each packet will be randomly delayed between this value and externalLatencyMax.

  This value can be overridden by a tag with the same name in the following sections:

  - `baseApp` - For more details, see “BaseApp Configuration Options” on page 15 .
  - `loginApp` - For more details, see “LoginApp Configuration Options” on page 39 .

  This feature is useful for testing during development.

See also ??? on page 9 , ??? on page 8

- **`externalLossRatio` (Float)**

  Proportion of outgoing packets that will be dropped by this processes external nub to simulate loss on the external network. This is a value between 0.0 and 1.0 indicating what proportion of packets will be dropped.

  This value can be overridden by a tag with the same name in the following sections:

  - `baseApp` - For more details, see "BaseApp Configuration Options" on page 15 .
  - `loginApp` - For more details, see "LoginApp Configuration Options" on page 39 .

  This feature is useful for testing during development.

  See also ??? on page 8 , ??? on page 8

- **`gameUpdateHertz` (Integer)**

  Number of times per second that the server should send an update to the clients. This corresponds to the game tick frequency.

- **`hasDevelopmentAssertions` (Boolean)**

  Flag indicating whether server should be aggressive in its use of assertions.

  This option should be set to true during development, and to false when running a production server.

  For example, if this option is set to true, then a corrupted packet sent from a client can cause an assertion on the server, while if this is set to false, then only an error message is generated and the server component continues to run.

- **`internalInterface` (String)**

  This tag is deprecated, and its use is not recommended. For details, see the document Server Overview's section Server Components → BWMachined → BWMachined interface discovery.

  Network adapter interface to use for internal communication, if not explicitly set by the server component.

  Accepted formats are:

  - **Adapter name** - Examples: `eth0`, `eth1`
  - **IP[/netmask]** - Examples: `10.5.2.1, 10.0.0.0/8`, `192.168.5.0/24`
  - **Domain name** - Examples: `intern0.clust/24`, `extern5.clust/24`

  This value can be overridden by a tag with the same name in the following sections:

  - `baseApp` - For details, see "BaseApp Configuration Options" on page 15 .
  - `baseAppMgr` - For details, see "BaseAppMgr Configuration Options" on page 22 .
  - `cellApp` - For details, see "CellApp Configuration Options" on page 25 .
  - `cellAppMgr` - For details, see "CellApp Configuration Options" on page 25 .
  - `dbMgr` - For details, see "DBMgr Configuration Options" on page 35 .

- `loginApp` - For details, see “LoginApp Configuration Options” on page 39 .

- **`internalLatencyMax` (Float)**

  Maximum number of seconds by which packets sent from the application's internal nub will be delayed.

  For more details, see `internalLatencyMin`.

  See also `internalLossRatio`.

- **`internalLatencyMin` (Float)**

  Minimum number of seconds by which packets sent from the application's internal nub will be delayed.

  Each packet will be randomly delayed between this value and `internalLatencyMax`.

  This feature is useful for testing during development.

  This value can be overridden by a tag with the same name in the following sections:

  - `baseApp` - For details, see “BaseApp Configuration Options” on page 15 .
  - `baseAppMgr` - For details, see “BaseAppMgr Configuration Options” on page 22 .
  - `cellApp` - For details, see “CellApp Configuration Options” on page 25 .
  - `cellAppMgr` - For details, see “CellApp Configuration Options” on page 25 .
  - `dbMgr` - For details, see “DBMgr Configuration Options” on page 35 .
  - `loginApp` - For details, see “LoginApp Configuration Options” on page 39 .
  - `reviver` - For details, see “Reviver Configuration Options” on page 42 .

  See also options `internalLatencyMax` and `internalLossRatio`.

- **`internalLossRatio` (Float)**

  Proportion of packets on this application's internal nub that will be dropped to simulate loss on the internal network. This is a ratio between 0.0 and 1.0.

  This feature is useful for testing during development.

  This value can be overridden by a tag with the same name in the following sections:

  - `baseApp` - For details, see “BaseApp Configuration Options” on page 15 .
  - `baseAppMgr` - For details, see “BaseAppMgr Configuration Options” on page 22 .
  - `cellApp` - For details, see “CellApp Configuration Options” on page 25 .
  - `cellAppMgr` - For details, see “CellApp Configuration Options” on page 25 .
  - `dbMgr` - For details, see “DBMgr Configuration Options” on page 35 .
  - `loginApp` - For details, see “LoginApp Configuration Options” on page 39 .
  - `reviver` - For details, see “Reviver Configuration Options” on page 42 .

  See also options `internalLatencyMax` and `internalLatencyMin`.

- **`loggerID` (Integer)**

  The ID used by the process when registering with MessageLoggers. If this ID does not match a MessageLogger's filter, the process will not log to that MessageLogger. (For details on MessageLogger, see “MessageLogger” on page 50).

  The value range of the ID is 0-255.

  Multiple BigWorld servers can share the same logger process. If this behaviour is not desired, then you can use a unique loggerID per server instance - this will cause MessageLogger to filter out all messages that do not match the loggerID it has been told to monitor.

- **`logSpamPatterns` (List of Strings)**

  A list of log message prefixes can be specified which will be suppressed on a per-second basis if the number sent to MessageLogger exceeds a certain threshold. Note that this is not intended a mechanism to sweep error messages "under the carpet"; it is designed to reduce the network load that can be generated by log traffic, which tests have indicated can be in excess of actual game traffic in some situations if suppression is disabled.

  This option can be overridden by a tag with the same name in any app section. Note that the overriding does not merge the suppression lists, it simply replaces the global list with the one defined at the app level.

  Additionally, the list of suppression patterns can be modified at runtime using the `logger/addSpamSuppressionPattern` and `logger/delSpamSuppressionPattern` watchers.

  Please see `bigworld/res/server/defaults.xml` for an example of a suppression list.

- **`logSpamThreshold` (Integer)**

  The number of a particular log message that can be sent to MessageLogger in a single second before suppression will take place. Note that only messages matching one of the `<logSpamPatterns>` (see above) will be suppressed.

- **`monitoringInterface` (String)**

  Network adapter interface to use for non-game communications, such as logging output, telnet sessions, and watcher requests. For example: `eth0`.

  See the BaseApp's configuration option externalInterface for accepted formats.

- **`numStartupRetries` (Integer)**

  Number of times that CellApps and BaseApps will try to locate other components when starting up.

  Each attempt is one second apart, so this value roughly indicates the number of seconds that these two components can be started before the other 'global' server components have started.

- **`outputFilterThreshold` (Integer)**

  Value used to filter the messages that are printed and sent to the logger.

  All messages are tagged with an integer value. If the message number is greater than or equal to the filter value, then the message is allowed (the bigger the value, the more messages are filtered out).

  For example, a threshold of 2 allows only INFO messages and higher (TRACE and DEBUG messages are filtered out).

  The possible values and their message thresholds are described in the list below:

  - **0 - `MESSAGE_PRIORITY_TRACE`**

- 1 - **MESSAGE_PRIORITY_DEBUG**
- 2 - **MESSAGE_PRIORITY_INFO**
- 3 - **MESSAGE_PRIORITY_NOTICE**
- 4 - **MESSAGE_PRIORITY_WARNING**
- 5 - **MESSAGE_PRIORITY_ERROR**
- 6 - **MESSAGE_PRIORITY_CRITICAL**
- 7 - **MESSAGE_PRIORITY_HACK**
- 8 - **MESSAGE_PRIORITY_SCRIPT**

- **`personality` (String)**

  Name of the personality module for the server.

  This module should contain things such as methods to be called back from the server (for example, when the server is ready). The personality module is usually named after your game.

  If not specified, the module named `BWPersonality` is used.

- **`production` (Boolean)**

  If set to `true`, enables the server processes to run in a production mode which makes a best attempt at emitting `ERROR` messages when encountering configuration settings that are considered detrimental for a production environment. In rare cases this may also prevent server processes from starting if the configuration options are seen to be completely unrealistic for a production environment.

  Currently this is a global configuration option and cannot be set per server application type.

- **`shutDownServerOnBadState` (Boolean)**

  Flag indicating whether server should be shut down when in an unrecoverable state.

  Currently, the following scenarios are handled:

  - All CellApps are dead.
  - Currently, the following scenarios are handled:
    - All BaseApps are dead.
    - Old BaseApp fault tolerance style is being used, and there are no backup BaseApps.
    - Two BaseApps die in quick succession, and thus base entities originally residing on the first BaseApp are not restored from the second one to a third one, and are therefore lost forever.

- **`shutDownServerOnBaseAppDeath` (Boolean)**

  If set to true, the entire server will be shut down if a single BaseApp dies. Normally, the fault tolerance system would allow the server to continue running.

- **`shutDownServerOnCellAppDeath` (Boolean)**

  If set to true, the entire server will be shut down if a single CellApp dies. Normally, the fault tolerance system would allow the server to continue running.

- **`shouldUseChecksums` (Boolean)**

  If set to true, then all packets sent between server components will be checksummed to verify their correctness. This is in addition to the UDP checksum automatically provided by the Linux kernel and protects against packet corruption by buggy network drivers. If a corrupted packet is detected by Mercury (meaning that it has somehow passed the UDP checksum), you will see an error message like:

  ```
  ERROR Nub::processFilteredPacket( 10.40.9.103:32823 ): Packet (flags 178, size 1459) failed checksum (wanted 3dc56738, got 9fe7000a)
  ```

  If after running servers for long enough and not seeing this error message you feel confident that the UDP checksum is reliable enough on your hardware, you can disable this option for a small performance improvement. The checksum is very simple and fast to calculate so this is likely to have only a small impact on performance.

- **`shuttingDownDelay` (Float)**

  Number of seconds that the server should wait before a requested controlled shutdown is actually performed.

- **`useDefaultSpace` (Boolean)**

  Flag indicating whether to automatically create an initial space when he server starts.

  This option is ignored if spaces are loaded from the database during start-up.

2.5. Network Configuration Options

The configuration options specified in this section relate to network communication and the behaviour of various aspects of communication channels.

The options specified in the following list are specifically related to the behaviour of channels when packets start overflowing. This can occur when the send window fills up and buffering of packets is required in order to handle packet resends.

The maximum packet options defines a per channel type threshold to assist in preventing channels from using indefinate amounts of memory while buffering overflow packets.

- **`maxChannelOverflow/isAssert` (Boolean)**

  Specifies whether the offending channel should raise a program assertion, effectively terminating the process, when the maximum number of overflow packets has been reached.

- **`maxChannelOverflow/external` (Integer)**

  Number of packets to allow to overflow on an *external* channel before raising an `ERROR` message, or `ASSERT`'ing if `<isAssert>` has been set to `true`. A value of `0` disables any log messages and assertions from occuring.

- **`maxChannelOverflow/internal` (Integer)**

  Number of packets to allow to overflow on an *internal* channel before raising an `ERROR` message, or `ASSERT`'ing if `<isAssert>` has been set to `true`. A value of `0` disables any log messages and assertions from occuring.

- **`maxChannelOverflow/indexed` (Integer)**

  Number of packets to allow to overflow on an *indexed* channel before raising an `ERROR` message, or `ASSERT`'ing if `<isAssert>` has been set to `true`. A value of `0` disables any log messages and assertions from occuring.

An indexed channel is a channel that is used for communicating directly to an entity.

2.6. Load Balancing Configuration Options

The load balancing configuration options are specified in file `<res>/server/bw.xml` under the section `<balance>`, and are described below:

- **`maxCPUOffload` (Float)**

  Estimated amount of CPU processing that can be offloaded from a cell to another in one tick of load balancing.

  A larger value should result in faster changes to the server's load balancing. This value is a fraction of 100% CPU usage, and its range is from 0.0 through 1.0, but is likely to always be less than 0.1.

- **`minEntityOffload` (Integer)**

  Using the option maxCPUOffload, the load balancing algorithm may decide that less than one entity needs to be offloaded. Since this can get rounded down to zero, the load balancing can get restricted when small adjustments need to be made.

  This option set a minimum value for this, so if it's set to 1 (the default), then the load balancing will have the capacity to make small adjustments.

- **`minMovement` (Float)**

  Minimum number of metres that a partition line should move when load balancing.

  A non-zero value can be useful to avoid the load balancing getting stuck.

- **`slowApproachFactor` (Float)**

  Aggressiveness of the load balancing when cells are close to being balanced.

  The value range is from 0 through 1.

  A smaller value will result in a slower approach to being balanced. Too high a value may result in some instability when the space is close to being balanced.

2.6.1. Entities Cardinality Configuration Options

The configuration options for load balancing based on the number of entities are specified in file `<res>/server/bw.xml` under section `<balance>/<demo>`, and are described below:

- **`enable` (Boolean)**

  Flag indicating whether the number of entities should be used to calculate load, rather than CPU load.

  In normal situations, the server uses the CPU load on the CellApps to load balance. But sometimes it is desirable to use the number of entities per CellApp instead.

  This may be useful, for example, when running multiple CellApps on a single machine for testing.

  See also option `demo/numEntitiesPerCell`.

- **`numEntitiesPerCell` (Float)**

  If option `demo/enable` is `true`, then this option is used for calculating a CellApp's load.

The load is calculated as `numEntities / numEntitiesPerCell`.

See also option `demo/enable`.

2.7. BaseApp Configuration Options

The BaseApp configuration options are specified in file `<res>/server/bw.xml` under the section `<baseApp>`, and are described below:

- **`archivePeriod` (Float)**

  Period length in seconds where each entity is written to the database for the purpose of disaster recovery. Each Entity is guaranteed to have an archive less than 2 x `archivePeriod` old. Setting it to zero switches off archiving.

  A large value increases performance, but reduces the effectiveness of eventual disaster recovery. The opposite is true for a small value.

  If secondary databases are disabled, this configuration option controls how often the entity is written to the primary database. In this case, this configuration option has a dramatic impact on the performance of the primary database when there are a large number of BaseApps. It is recommended to start with large values (a few minutes), and perform database testing and tuning before reducing it.

  If secondary databases are enabled, this configuration option controls how often the entity is written to the secondary database. In this case, this configuration option can be set to a relatively small value (less than a minute) since it only impacts the BaseApp machine and the load is independent of number of BaseApps - unless the secondary database directory is on a shared network drive. For more details on secondary databases, see Server Programming Guide's chapter Secondary Databases.

  This option is also available for CellAppMgr.

- **`backupPeriod` (Float)**

  Number of seconds between backups of each base entity to its backup BaseApp. This value is rounded to the nearest game tick.

  As a first level of fault tolerance, base entities can be copied to a backup BaseApp (*i.e.*, backup to RAM), while cell entities are copied to their base entity. For more details on BaseApp and CellApp fault tolerance, see the document Server Programming Guide's chapter Fault Tolerance.

  The value for this option is very dependant on the game. A small value means frequent backups, and consequently less lost data in case a BaseApp fails. But backups cost bandwidth and CPU on the BaseApp.

  In general this period can be much smaller than the one specified in option archivePeriod.

  See also option `backupPeriod` on “CellApp Configuration Options” on page 25 .

- **`backupTimeout` (Float)**

  Number of seconds for a BaseApp to respond to the watchdog messages from its backup BaseApp before it is considered dead and the backup BaseApp takes its place.

- **`backUpUndefinedProperties` (Boolean)**

  Flag indicating whether undefined properties should be backed up.

  Properties of an entity are defined in the entity's definition file. However, it is possible to define additional properties for this entity in the base script of this entity. For example, an additional property can be

defined by initialising it in the constructor of this entity class. These additional properties are referred to as undefined properties.

If this option is set to true, undefined properties will be backed up and an error will be emitted for each of the properties that cannot be pickled. If this option is set to false, undefined properties will not be backed up. Default value is true.

- **`clientOverflowLimit` (Integer)**

  If the send window for the channel to the client grows larger than this many packets, the client is disconnected.

  Generally, it is better to rely on `inactivityTimeout` to detect an unresponsive client and so this option should be set to greater than `inactivityTimeout * gameUpdateHertz`.

  See also option `inactivityTimeout` on "BaseApp Configuration Options" on page 15

- **`createBaseElsewhereThreshold` (Float)**

  Threshold of local BaseApp load below which calls to `BigWorld.createBaseAnywhere` cause the new base entity to be created locally.

- **`externalInterface`**

  For details, see "General Configuration Options" on page 7 .

- **`externalLatencyMax`**

  For details, see "General Configuration Options" on page 7 .

- **`externalLatencyMin`**

  For details, see "General Configuration Options" on page 7 .

- **`externalLossRatio`**

  For details, see "General Configuration Options" on page 7 .

- **`externalPort` (Integer)**

  Port that may be used for the BaseApp's external socket - the BaseApp can have more than one `externalPort` definition.

  This option is useful when BaseApp is running behind a firewall and NAT port mappings need to be set up.

  If the BaseApps are run behind a firewall, then each BaseApp expected to run on a single machine should have an externalPort definition.

  If this option is not specified, or all specified externalPorts are taken. then the BaseApp will bind to any available port on the external interface.

- **`inactivityTimeout` (Integer)**

  Number of seconds that a proxy will proceed without communication from the client before it considers the connection to be dead.

  See also option `clientOverflowLimit` on "BaseApp Configuration Options" on page 15

- **`internalInterface`**

  For details, see "General Configuration Options" on page 7 .

This tag is deprecated, and its use is not recommended. For details, see the document Server Overview's section Server Components → BWMachined → BWMachined interface discovery.

- **`internalLatencyMax`**

  For details, see "General Configuration Options" on page 7 .

- **`internalLatencyMin`**

  For details, see "General Configuration Options" on page 7 .

- **`internalLossRatio`**

  For details, see "General Configuration Options" on page 7 .

- **`loadSmoothingBias` (Float)**

  Value to smooth the load changes on a component by when calculating new load.

  The BigWorld server uses the load on a component to perform its load balancing. Unfiltered, the load can change too quickly to be useful. The option loadSmoothingBias is used to smooth out this value.

  The filtered value is calculated at each game tick as follows:

  ```
  newSmoothedLoad = (1 - loadSmoothingBias) * oldSmoothedLoad + loadSmoothingBias
  * load
  ```

  This option is also available for CellApps and CellAppMgr.

- **`minClientInactivityResendDelay` (Float)**

  Minimum number of seconds that the BaseApp waits before resending unacknowledged packets to the client. BigWorld also uses other metrics like the round-trip-time to the client to adjust the resend timeout period. However, BigWorld will not set the resend timeout period to less than the value specified in this configuration option.

  The BaseApp will resend packets to the client due various reasons like lost packets, network jitter or client delays in sending packet acknowledgements. Increasing the minimum resend delay will generally reduce the number of packet resends. However, increasing this value will also increase the impact of a lost packet on the end user experience. The client will only process packets in order. Therefore, a lost packet will cause the client to buffer subsequent packets from the server and wait for the lost packet to arrive. If the resend timeout is long, the user will notice a temporary halting of updates from the server.

- **`noSuchPortTimeout` (Float)**

  Number of seconds of grace given to a client connection encountering a `REASON_NO_SUCH_PORT` error before the connection is terminated.

  The `REASON_NO_SUCH_PORT` error indicates that the host is no longer reachable, a condition that is sometimes temporary, caused by intermittent network problems.

  Note that this setting is only approximate - the timeout is shortened if the server sends more than one packet per tick to the client.

- **`oldStyleBaseDestroy` (Boolean)**

  This tag is deprecated, and its use is not recommended. This option is planned for removal in BigWorld 2.0.

  Flag indicating whether the destruction of a base entity should be carried out like in BigWorld versions earlier than 1.6.

In those versions, the base entity could be destroyed before the cell entity; doing so would also destroy the cell entity. From BigWorld 1.6 and later versions, the base entity must be destroyed after the cell entity. Calling the method Base.destroy on an entity that still has its cell part raises a Python exception.

If this option is set to true, calling the method Base.destroy on an entity with a cell part causes the method Base.destroyCellEntity to be called. After the cell entity has been destroyed, it the callback onLoseCell is not implemented on the base entity, then the base entity is destroyed.

- **`pythonPort` (Integer)**

  Port that the Python telnet session listener should listen on.

  If set to zero, then a random port is chosen.

  If the option is missing, then the port number will be set according to the formula:

  ```
  40,000 + BaseApp ID
  ```

  If the desired port is not available in any case, then a random one is used.

  This option is also available for CellApps.

- **`reservedTickFraction` (Float)**

  Percentage of tick time that should be remaining on current tick so the next one is considered to be pending.

  This value is expressed as fraction. For example, setting it to 0.2 means that the next tick will be considered pending when there is still 20% of the current tick's time remaining.

  Increasing this parameter will make the server more conservative in its CPU usage.

  This affects how aggressive the method `BigWorld.fetchFromChunks` will be about yielding processing to the next tick.

  Note: This should rarely be changed from the default value.

- **`sendAuthToClient` (Boolean)**

  Flag indicating whether BaseApps must send authentication messages to clients (clients always send authentication to the server).

  Use this feature to avoid hacking of clients, and prevent users from spoofing server messages to other clients.

  Without this authentication, someone can send fake messages to clients, pretending to be the server (they will need the IP address of the client, and the port that the server is using, which can only be determined from the target client's data stream).

  This option's value defaults to false, in order to save bandwidth.

- **`sendWindowCallbackThreshold` (Float)**

  The fraction of an entity channel's send window that needs to be used before the `onWindowOverflow` callback is called on the associated Base entity.

- **`shouldResolveMailBoxes` (Boolean)**

  Flag indicating whether a mailbox shoud be resolved to a Base entity, when possible. If a mailbox refers to a Base entity on the local BaseApp, the entity is used instead of the mailbox.

Although it is more efficient to have this option set, it is generally better to have it disabled. Having this enabled can lead to hard to find errors as behaviour changes depending on whether an entity happens to be local or not.

- **`verboseExternalNub` (Boolean)**

  Flag indicating whether to generate verbose log output related to external network traffic.

- **`warnOnNoDef` (Boolean)**

  Flag indicating whether to generate a warning when Base entity properties are set that do not have a description in the entity's def file.

- **`watcherValues` (String)**

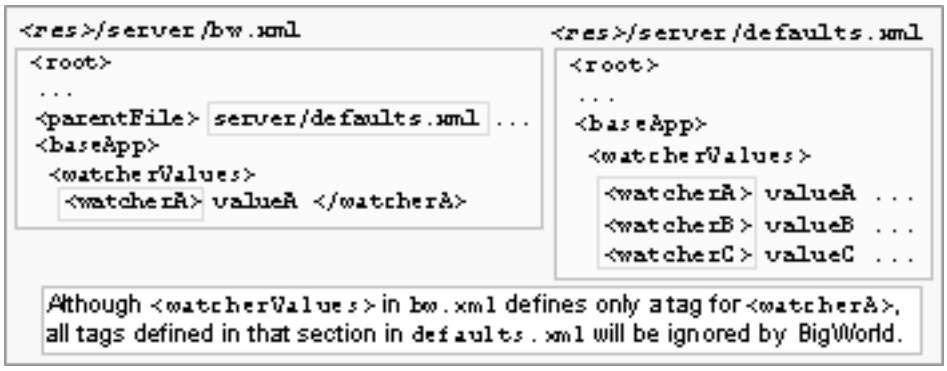
  This is not an actual configuration option, but instead a sub-section inside the section `<baseApp>`, used to set arbitrary watcher values for the BaseApp at initialisation time.

  This might be useful when there is a watcher value with no corresponding entry on file *`<res>`*`/server/bw.xml`.

  For example, to set value of `debug/baseapp.cpp` to 2:

```
<baseApp>
  <watcherValues>
    <debug>
      <baseapp.cpp> 2 </baseapp.cpp>
      ...
```

  Do not use this feature if there is a parameter that can be set directly. Like all configuration options, this one is only evaluated once. It means that if there is an entry for watcherValues in *`<res>`*`/server/defaults.xml`, then all tags defined in it will be ignored if *`<res>`*`/server/ bw.xml` also has an entry for `watcherValues` (even if different tags are specified in each one). This option is also available for CellApps.



File hierarchy

- **`writePythonLog` (Boolean)**

  Flag indicating whether to write the output of Python scripts to the local log file `<game_executable_folder>/python.log`.

  This should generally be set to false, since the data is sent to the central logger anyway, and the disk I/O generated by logging could block the process.

This option is also available for CellApps.

2.7.1. Secondary Database Configuration Options

The BaseApp secondary database configuration options are specified in file `<res>/server/ bw.xml` under section `<baseApp>/<secondaryDB>`, and are described below:

- **`enable` (Boolean)**

  Flag indicating whether to use secondary databases.

  For more details about secondary databases, see Server Programming Guide 's section Secondary Databases.

- **`maxCommitPeriod` (Float)**

  Maximum number of seconds between each commit. Higher values will result in better performance. Lower values will reduce the amount of data loss in case of a total system crash.

  Explicit `BigWorld.writeToDB` calls will always result in a commit. This option only affects the automatic archiving of entities.

  If set to zero or this option is empty, the value defaults to 5.

- **`directory` (String)**

  Directory where the secondary database files are stored. Secondary databases are SQLite files.

  The secondary database files are cleaned up when the system shuts down. However, these files should not be treated as normal temporary files since they are crucial to the data recovery process in case of a complete system crash.

  If the first character of the path is a `/` character, the path is treated as an absolute path. Otherwise, the path is treated as relative to the first `<res>` path that contains the directory.

2.7.2. Packet Log Configuration Options

The BaseApp packet logging configuration options are specified in file `<res>/server/ bw.xml` under section `<baseApp>/<packetLog>`, and are described below:

- **`addr` (String)**

  Client for which the packet's content should be logged.

  The address is specified as dotted decimal format (*e.g.*, 10.40.1.1).

  If this option is empty, then all packets will be logged.

- **`enable` (Boolean)**

  Flag indicating whether to write all packets to a local log file proxy.log.

  This can be useful for debugging.

- **`flushMode` (Boolean)**

  Flag indicating whether the log file should be flushed after each write.

  This option is useful to ensure all log writes are captured if the BaseApp is crashing.

- **`hexMode` (Boolean)**

Flag indicating whether the logged packets' contents should be written in hexadecimal.

2.7.3. ID Configuration Options

The BaseApp ID configuration options are specified in file `<res>/server/bw.xml` under section `<baseApp>/<ids>`, and are described below:

- **`criticallyLowSize` (Integer)**

  Minimum number of IDs in the BaseApp's available ID pool before the other limits are automatically adjusted.

  The adjustment aims to help avoid this from occurring again.

- **`desiredSize` (Integer)**

  Target number of IDs in the BaseApp's available ID pool when requesting IDs to the parent broker ID (in case it fell below `lowSize`), or returning IDs to it (in case it rose above highLevel) - for CellApps and BaseApps, the parent ID broker is the CellAppMgr, while for CellAppMgr it is DBMgr.

- **`highSize` (Integer)**

  Maximum number of IDs in the BaseApp's available ID pool before IDs are returned to the parent ID broker - for CellApps and BaseApps, the parent ID broker is the CellAppMgr, while for CellAppMgr it is DBMgr.

  ID recycling is currently disabled, so this value is actually never used.

- **`lowSize` (Integer)**

  Minimum number of IDs that should be available in the BaseApp's available ID pool before a request is sent to the parent ID broker to restore it to the value specified in configuration option `desiredSize` - for CellApps and BaseApps, the parent ID broker is the CellAppMgr, while for CellAppMgr it is DBMgr.

2.7.4. Client Upstream Limits

The client upstream bandwidth can be limited so as to prevent denial-of-service attacks from malicious clients, or errant script code that cause messages from the client to be sent in high volume. This can lead to Mercury channels within the server to become heavily loaded.

To prevent this, limits can be specified on the count and size of incoming messages from clients to BaseApps. Once hard limits are reached on the count/size of incoming messages, messages are buffered and played back over time. Once the hard limits on buffering are reached, clients are disconnected.

The configuration parameters are specified in the file `<res>/server/bw.xml` in the `<baseApp>/<clientUpstreamLimits>` section. The available sub-elements are described in the following table.

- **`warnMessagesPerSecond` (Integer)**

  This is a warning limit for the number of received messages from a client that are dispatched, measured in number of messages per second. When messages are received above this limit, a warning is emitted. No further warnings for this client of this type are emitted until the incoming message frequency drops below this limit.

- **`maxMessagesPerSecond` (Integer)**

  This is a hard limit for the number of received messages from a client that are dispatched, measured in number of messages per second. When messages are received above this limit, those and subsequent messages are buffered for later playback until the buffer is empty. The message queue for all clients are checked every tick to replay any eligible messages.

- **`warnBytesPerSecond` (Integer)**

  This is a warning limit for the throughput (in bytes) of received messages that are dispatched, measured in bytes per second. When this limit is exceeded, a warning is emitted. No further warnings for this client of this type are emitted until the incomng message data throughput drops below this limit.

- **`maxBytesPerSecond` (Integer)**

  This is a hard limit for the size of data (in bytes) in received messages that are dispatched per second. When messages are received above this limit, those and subsequent messages are buffered for later playback until the buffer is empty. The message queue for all clients are checked every tick to replay any eligible messages.

- **`warnMessagesBuffered` (Integer)**

  This is a warning limit for the number of received messages that may be buffered from the client. When this limit is exceeded, a warning is emitted. No further warnings for this client of this type are emitted until the number of queued messages drops below this threshold as a result of queue playback.

- **`maxMessagesBuffered` (Integer)**

  This is a maximum limit for the number of received messages that may be buffered from the client. When this limit is exceeded, the client is disconnected and any messages that are buffered are discarded and not dispatched.

- **`warnBytesBuffered` (Integer)**

  This is a warning limit for the total number of bytes that may be buffered for a client. When this limit is exceeded, a warning is emitted. No further warnings for this client of this type are emitted until the total size of buffered messages drops below this threshold as a result of queue playback.

- **`maxBytesBuffered` (Integer)**

  This is a maximum limit for the total number of bytes that may be buffered for a client. When this limit is exceeded, the client is disconnected and any messages that are buffered are discarded and not dispatched.

2.8. BaseAppMgr Configuration Options

The BaseAppMgr configuration options are specified in file `<res>/server/bw.xml` under section `baseAppMgr`, and are described below:

- **`baseAppOverloadLevel` (Float)**

  Minimum load level that all BaseApps should reach for the system to be considered in overload, and thus reject new logins.

  Similar overload levels are specified for for any CellApp (by option `<cellAppOverloadLevel>` - for more details, see “CellAppMgr Configuration Options” on page 32), and for DBMgr (by option `<overloadLevel>` - for more details, see “DBMgr Configuration Options” on page 35).

- **`baseAppTimeout` (Float)**

  Number of seconds for a BaseApp to respond before it is considered dead.

- **`hardKillDeadBaseApps` (Boolean)**

  Determines if a non-responsive BaseApp will be terminated with a SIGQUIT signal.

  Non-responsive BaseApps must be terminated in order for its backup to take over its IP address and ID. BaseApp non-responsiveness is determined by its backup, so a BaseApp running without a backup

will never be reported as being non-responsive (see also configuration option baseApp/backupTimeout in "BaseApp Configuration Options" on page 15).

When this option is set to false, no signal is sent to the non-responsive BaseApp.

Only use this option for debugging, *e.g.*, to attach a debugger to the hung process.

- **`internalInterface`**

  For details, see "General Configuration Options" on page 7 .

  This tag is deprecated, and its use is not recommended. For details, see the document Server Overview's section Server Components → BWMachined → BWMachined interface discovery.

- **`internalLatencyMax`**

  For details, see "General Configuration Options" on page 7 .

- **`internalLatencyMin`**

  For details, see "General Configuration Options" on page 7 .

- **`internalLossRatio`**

  For details, see "General Configuration Options" on page 7 .

- **`overloadLogins`** **(Integer)**

  Maximum amount of logins that will be accepted during the overload tolerance period (see the `overloadTolerancePeriod` option) before rejecting any further logins.

- **`overloadTolerancePeriod`** **(Float)**

  Number of seconds that logins will be accepted during a situation where the BaseApps are overloaded (see the `baseAppOverloadLevel` option). After this period of time, any further logins will be rejected.

- **`timeSyncPeriod`** **(Float)**

  Number of seconds between each synchronisation of game time between BaseAppMgr and CellAppMgr.

- **`useNewStyleBackup`** **(Boolean)**

  Old-style backup is deprecated and its use is not recommended. It is planned for removal in BigWorld 2.0.

  Flag indicating whether Distributed BaseApp Backup method should be used, instead of the older Non-distributed BaseApp Backup method.

  In the Distributed BaseApp Backup method, a BaseApp's entities are backed up in various other real BaseApps, while in the Non-distributed BaseApp Backup method, various BaseApps would back up all their entities on a dedicated Backup BaseApp.

  For details, see "BaseApp Fault Tolerance" on page 86, and the document Server Overview's section Server Components → BaseApp → Fault tolerance.

2.9. Bots Configuration Options

The Bots configuration options are specified in file `<res>/server/bw.xml` under the section `<bots>`, and are described below:

- **`controllerData`** **(String)**

Default data that the bot's controller will be created with (when bots are created, they get a controller associated with them to control their movement).

This may have different meanings for different controller types. For example, some controller types may interpret this as a filename to load data from.

- **`controllerType` (String)**

  Type of the controller to be created with bot.

- **`password` (String)**

  Password that the bots should use when logging in to the server.

- **`port` (Integer)**

  Port on the server machine in which bots process will log to (only used if the option `<serverName>` is specified).

  Ignored if bots automatically locates the LoginApp.

- **`pythonPort` (Integer)**

  Port that the Python telnet session listener should listen to.

- **`randomName` (Boolean)**

  Flag indicating whether a random suffix should be added to each bots name, in order to make them unique.

  You should only set this option to false if you plan to use only a single bot. If you plan to use more than one bot, then you will need them to have different names - otherwise only the first one will be able to log in.

  See also option `username`.

- **`scripts` (Boolean)**

  Flag indicating whether the bots process should use Python scripting for received entities.

  If set to `false`, then received entities are effectively ignored. Turning this option on has a significant performance penalty.

- **`serverName` (String)**

  Name of the server machine that the bots process should log in to (*i.e.*, the machine running LoginApp).

  If this option is empty, then the bots process will attempt to find an appropriate LoginApp on the local network.

- **`shouldLog` (Boolean)**

  Flag indicating whether messages generated by the bots process should be sent to the central logger.

- **standinEntity(String)**

  Default entity script to be used when a specific Entity type does not have its corresponding game script.

- **loginMD5Digest(String)**

  MD5 digest string (in hex readable form) for server login.

- **`userName` (String)**

Username that bots should use when logging in to the server.

When randomName is true, this is the prefix before the randomly generated part of the name.

See also option `randomName`.

2.10. CellApp Configuration Options

The CellApp configuration options are specified in file `<res>/server/bw.xml` under the section `<cellApp>`, and are described below:

- **`backupPeriod` (Float)**

  Number of seconds between backups of each cell entity to its base entity. This value is rounded to the nearest game tick.

  As a first level of fault tolerance, cell entities are copied to their base entities, while base entities can be copied to their backup BaseApps. For more details on BaseApp and CellApp fault tolerance, see the document Server Programming Guide's chapter Fault Tolerance.

  The value for this option is very dependant on the game. A small value means frequent backups, and consequently less lost data in case a CellApp fails. But backups cost bandwidth and CPU on the CellApp.

  See also options `archivePeriod` and `backupPeriod` on “BaseApp Configuration Options” on page 15 .

- **`checkOffloadsPeriod` (Float)**

  Number of seconds between offload checks.

  This is a periodic check if entities need to be offloaded, or new ghosts created.

  Other options affected by this setting are: `ghostingMaxPerCheck` and `offloadMaxPerCheck`.

- **`chunkLoadingPeriod` (Float)**

  Number of seconds between checks on the progress of loading and unloading chunks.

  Chunk loading occurs in a separate thread, but this check in the main thread queues up more chunks for the loading thread to load (or unload).

- **`defaultAoIRadius` (Float)**

  The default AoI radius of new cell entities for proxy entities when they are created. See also the CellApp Python API documentation's entry **Main → Cell → BigWorld → Classes → Entity → `setAoIRadius`**.

  Note: If this is larger than `GHOST_DISTANCE` (500m), then the AoI radius of player entities is clamped to `GHOST_DISTANCE` across cell boundaries.

- **`enforceGhostDecorators` (Boolean)**

  Specifies whether to enforce the requirement of adding a decorator to methods that can safely be called on ghost entities.

  When enabled, methods that have not been labelled as safe and are called on an entity that could be a ghost will generate a Python exception. To be considered safe, the method must either be described in the `.def` file or be decorated with `@bwdecorators.callableOnGhost`.

```
import bwdecorators
```

```
class Table( BigWorld.Entity ):
 @bwdecorators.callableOnGhost
 def getArea( self ):
  return self.width * self.height
```

- **`entitySpamSize` (Integer)**

  Number of bytes that an entity can send to another before a warning message is displayed.

  This can be useful to identify entities that are causing a lot of network traffic.

- **`fastShutdown` (Boolean)**

  Specifies whether to avoid normal chunk unloading when the system is being shut down. This considerably speeds up the shutdown process.

- **`ghostingMaxPerCheck` (Integer)**

  Maximum number of ghost creation messages that can be sent per offload check.

  The frequency of the offload check is determined by option `checkOffloadsPeriod`.

- **`ghostUpdateHertz` (Integer)**

  Number of seconds between the flushing messages to channels of neighbouring CellApps.

  Channels are created between neighbouring CellApps. Messages (such as ghost data) sent over these channels are not sent immediately, but are instead flushed periodically. This is done to avoid the high overhead of sending a packet.

  If the value of this option is decreased, then there will be more lag for cross-cell communications.

  Be careful about increasing this value, because CellApps have a fixed window size, after which they are flagged as dead. This window is currently 4096, which mean that if 4,096 packets are not acknowledged, then the CellApp is flagged as dead. At 50Hz, this takes around a minute, which is enough to survive occasional heavy bouts of unexpected swapping.

  Note: Bases always flush messages immediately.

- **`internalInterface`**

  For details, see “General Configuration Options” on page 7 .

  This tag is deprecated, and its use is not recommended. For details, see the document Server Overview's section Server Components, BWMachined, BWMachined interface discovery.

- **`internalLatencyMax`**

  For details, see “General Configuration Options” on page 7 .

- **`internalLatencyMin`**

  For details, see “General Configuration Options” on page 7 .

- **`internalLossRatio`**

  For details, see “General Configuration Options” on page 7 .

- **`loadDominantTextureMaps` (Boolean)**

  Specifies whether to load the terrain's dominant texture maps. By default, this flag is set to `false`.

Loading the dominant texture maps enables using features such as material kinds returned by `BigWorld.collide`.

- **`loadSmoothingBias` (Float)**

  Value to smooth the load changes on a component by when calculating new load.

  The BigWorld server uses the load on a component to perform its load balancing. Unfiltered, the load can change too quickly to be useful. The option `loadSmoothingBias` is used to smooth out this value.

  The filtered value is calculated at each game tick as follows:

  newSmoothedLoad = (1 - loadSmoothingBias) * oldSmoothedLoad + loadSmoothingBias * load

  This option is also available for CellAppMgr and BaseApps.

- **`maxControllersAbsolute` (Integer)**

  Number of controllers that an entity must have before an exception is raised on attempts to create a new controller on it.

- **`maxControllersExpected` (Integer)**

  Minimum number of controllers an entity must have before a warning is generated on attempts to create a new controller on it.

- **`maxGhostsToDelete` (Integer)**

  Maximum number of ghosts to be deleted from other cells on every offload check (the frequency of this check is set via checkOffloadsPeriod).

  This option is useful for adding antihysteresis and for smoothing the load caused by ghost deletion.

- **`minGhostLifespan` (Float)**

  Minimum number of seconds for which a real entity will keep a ghost one.

  This is useful for adding antihysteresis to the ghost creation and to the deletion process.

- **`maxPhysicsNetworkJitter` (Float)**

  Maximum number of seconds to allow for when network jitter when considering movement cheating.

  The movement of a player may vary slightly due to variations in network latency. This value sets the level of tolerance for this jitter.

- **`navigatorUseGirthGrids` (Boolean)**

  Specifies if the waypoint search optimisation scheme should be used.

  Girth grid is an optimisation scheme for waypoint search in a chunk. When this scheme is used, a chunk is divided up into a set of 12x12 grids according to the girth provided (you can have a list of 12x12 grid set for different girth sizes). Every grid square contains a subset of waypoints that overlap the covered area in a chunk.

  During a (waypoint) search, only targeted grid squares (*i.e.*, subset of waypoints) are searched for the waypoint, instead of searching through the full set of waypoints. This scheme will generally improve the waypoint search performance.

- **`obstacleTreeDepth` (Integer)**

  Depth of the obstacle tree to create.

  Higher numbers increase the speed of collision detection but use more memory.

- **`offloadHysteresis` (Float)**

  Number of metres that an entity has to be over a cell boundary before it is actually offloaded.

  This helps avoid entities being offloaded back and forth between cells when standing very close to the border.

- **`offloadMaxPerCheck` (Integer)**

  Maximum number of entities that can be offloaded from a cell during an offload check.

  The frequency of the offload check is determined by option checkOffloadsPeriod.

- **`pythonPort` (Integer)**

  Port that the Python telnet session listener should listen on.

  If set to zero, then a random port is chosen.

  If the option is missing, then the port number will be set according to the formula:

  50,000 + CellApp ID

  If the desired port is not available in any case, then a random one is used.

  This option is also available for CellApps.

- **`reservedTickFraction` (Float)**

  Percentage of tick time that should be remaining on current tick so the next one is considered to be pending.

  This value is expressed as fraction. For example, setting it to 0.2 means that the next tick will be considered pending when there is still 20% of the current tick's time remaining.

  Increasing this parameter will make the server more conservative in its CPU usage.

  This affects how aggressive the method `BigWorld.fetchFromChunks` will be about yielding processing to the next tick.

  Note: This should rarely be changed from the default value.

- **`sendWindowCallbackThreshold` (Float)**

  The fraction of an entity channel's send window that needs to be used before the `onWindowOverflow` callback is called on the associated entity.

- **`shouldResolveMailBoxes` (Boolean)**

  Flag indicating whether a mailbox shoud be resolved to a Cell entity, when possible. If a mailbox refers to a Cell entity on the local CellApp, the entity is used instead of the mailbox.

  Although it is more efficient to have this option set, it is generally better to have it disabled. Having this enabled can lead to hard to find errors as behaviour changes depending on whether an entity happens to be local or not.

- **`treatAllOtherEntitiesAsGhosts` (Boolean)**

  Puts the CellApp in a debugging mode in which a script running on it will see only its own entity as real - all other entities will be treated as ghosts.

  Method calls, property access, and other functions will operate as if the other entities really are ghosts. This mean that:

  - Method calls will go via the network.
  - Property access will be read-only, and limited to `CELL_PUBLIC` (or more public) properties (for more details, see the document Server Programming Guide's section Properties → Data distribution).
  - Many internal functions will not work, *e.g.*, adding a new Controller.

  This is very useful for testing how your scripts work when dealing with ghost entities, especially if two interacting entities are nearby and would consequently rarely be ghosts.

- **`watcherValues` (String)**

  This is not an actual configuration option, but instead a sub-section inside the section `cellApp`, used to set arbitrary watcher values for the CellApp at initialisation time.

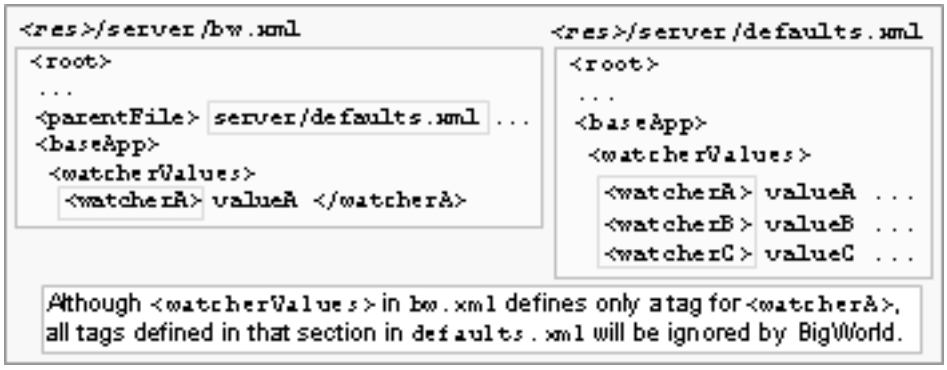
  This might be useful when there is a watcher value with no corresponding entry on `<res>/server/bw.xml`.

  For example, to set the watcher value `debug/cellapp.cpp` to 2:

```
<cellApp>
  <watcherValues>
    <debug>
      <cellapp.cpp> 2 </cellapp.cpp>
      ...
```

  Do not use this feature if there is a parameter that can be set directly.

  Like all configuration options, this one is only evaluated once. It means that if there is an entry for watcherValues in `<res>/server/defaults.xml`, then all tags defined in it will be ignored if `<res>/server/bw.xml` also has an entry for `watcherValues` (even if different tags are specified in each one). This option is also available for BaseApps.



File hierarchy

- **`writePythonLog` (Boolean)**

  Indicates if output of Python scripts should be written to `<game_executable_folder>/python.log`.

This should generally be set to false, since the data is sent to the central logger anyway, and the disk I/O generated by logging could block the process.

This option is also available for BaseApps.

2.10.1. Noise Configuration Options

The CellApp noise configuration options are specified in file `<res>/server/bw.xml` under section `<cellApp>/<noise>`, and are described below:

- **`horizontalSpeed` (Float)**

  If an entity's horizontal speed exceeds this value (in metres per second), the entity makes a noise.

  See `Entity.makeNoise` script method for more information. The event and info are 0 for noises generated this way.

- **`standardRange` (Float)**

  Distance in metres through which a noise is propagated.

  This value is multiplied by the level of a noise. For details, see the CellApp Python API documentation's entry **Main → Cell → BigWorld → Classes → Entity → `makeNoise`**.

- **`verticalSpeed` (Float)**

  If an entity's falling speed exceeds this value (in metres per second), the entity makes a noise.

  This is done via script method `Entity.makeNoise` - for noises generated this way, the parameter event and info are set to 0. For details, see the CellApp Python API documentation's entry **Main → Cell → BigWorld → Classes → Entity → `makeNoise`**.

2.10.2. ID Configuration Options

The CellApp ID configuration options are specified in file `<res>/server/bw.xml` under section `<cellApp>/<ids>`, and are described below:

- **`criticallyLowSize` (Integer)**

  Minimum number of IDs in the CellApp's available ID pool before the other limits are automatically adjusted.

  The adjustment aims to help avoid this from occurring again.

- **`desiredSize` (Integer)**

  Target number of IDs in the CellApp's available ID pool when requesting IDs to the parent broker ID (in case it fell below `lowSize`), or returning IDs to it (in case it rose above `highSize`) - for CellApps and BaseApps, the parent ID broker is the CellAppMgr, and for CellAppMgr it is DBMgr.

- **`highSize` (Integer)**

  Maximum number of IDs in the CellApp's available ID pool before IDs are returned to the parent ID broker - for CellApps and BaseApps, the parent ID broker is the CellAppMgr, and for CellAppMgr it is DBMgr.

  ID recycling is currently disabled, so this value is actually never used.

- **`lowSize` (Integer)**

Minimum number of IDs that should be available in the CellApp's available ID pool before a request is sent to the parent ID broker to restore it to the value specified in configuration option desiredSize - for CellApps and BaseApps, the parent ID broker is the CellAppMgr, and for CellAppMgr it is DBMgr.

2.10.3. CellApp Profiles Configuration Options

The CellApp profiles configuration options are specified in file `<res>/server/bw.xml` under section `<cellApp>/<profiles>`. It contains sub-sections for enabling profiling of specific CellApp functionality. All the profiling options specified below can be modified after server startup on a per CellApp basis by using Watchers. The values are exposed in the CellApp watcher tree under `profilesConfigs/<option>`.

The list below details the available profiling sub-sections and options:

- **`initGhost`**

  The **`initGhost`** sub-options define profiling information relating to the initialisation of ghost entities. Specifically the maximum time taken and network stream size required to initialise ghost entities from their reals after which a `WARNING` message will be generated. The initialisation primarily consists of the streaming of ghosted entity properties.

  - **`sizeWarningLevel` (Integer)**

    The size (in bytes) that an `initGhost`() method receives before a `WARNING` message is displayed.

  - **`timeWarningLevel` (Float)**

    The amount of time (in seconds) that an `initGhost`() method can take before a `WARNING` message is displayed. An example of the type of message generated is as follows.

    ```
    WARNING    Profile initGhost/timeWarningLevel exceeded (Creature 23 of size
     12338 bytes took 0.00477 seconds)
    ```

- **`initReal`**

  Similar to the **`initGhost`** option, the **`initReal`** sub-options define profiling information relating to the initialisation of real entities. Specifically the maximum time taken and network stream size required to initialise real entities from their reals after which a `WARNING` message will be generated. The initialisation primarily consists of the streaming of entity properties.

  - **`sizeWarningLevel` (Integer)**

    The size (in bytes) that an `initReal`() method receives before a `WARNING` message is displayed. An example of the type of message generated is as follows.

    ```
    WARNING    Profile initReal/sizeWarningLevel exceeded (Creature 13 of size
     68765 bytes took 0.3726 seconds)
    ```

  - **`timeWarningLevel` (Float)**

    The amount of time (in seconds) that an `initReal`() method can take before a `WARNING` message is displayed.

- **`onLoad`**

  The `onLoad`() operation is invoked when creating a real entity that had been offloaded from another CellApp.

- **`sizeWarningLevel` (Integer)**

  The size (in bytes) that an `onLoad()` method receives before a `WARNING` message is displayed. An example of the type of message generated is as follows. The size is considered as the total size of the real entity and which is comprised of non-ghosted (i.e. CELL_PRIVATE) properties and other state information such as entities in the AoI, controller state etc.

- **`timeWarningLevel` (Float)**

  The amount of time (in seconds) that an `onLoad()` method can take before a `WARNING` message is displayed.

- **`backup/sizeWarningLevel` (Integer)**

  `backup` is the operation of performing a fixed point in time copy of the cell entity to the database (via the base). The size (in bytes) is the maximum persistent size of the entity (*i.e.* only persistent properties) after which a `WARNING` message is displayed.

2.11. CellAppMgr Configuration Options

The CellAppMgr configuration options are specified in file `<res>/server/bw.xml` under the section `<CellAppMgr>`, and are described below:

- **`archivePeriod` (Float)**

  Number of seconds between database writes of space configuration and space data, for the purpose of disaster recovery.

  Setting it to zero switches off database writes.

  A large value increases performance, but reduces the effectiveness of eventual disaster recovery. The opposite is true for a small value.

  Please note that unlike the BaseApp configuration option of the same name, this configuration option is not affected by the use of secondary databases. The data is always written to the primary database. It is recommended to start with large values (a few minutes), and perform database testing and tuning before reducing it.

  This option is also available for BaseApps.

- **`archiveSpaceData` (Boolean)**

  Boolean indicating whether or not the space data should be archived to the database during each `archivePeriod`. Disabling this will help reduce database load if your game is not reliant on recovering spaces to their previous configuration after a server crash.

- **`cellAppLoadLowerBound` (Float)**

  Minimum average load that a CellApp must achieve before being retired.

  This value is a fraction, and its range is 0.0 through 1.0.

  Together with `cellAppLoadUpperBound`, this option should be tuned as to conserve CPU, while still allowing for temporary overloads (which depend on game code characteristics, such as AI usage).

  This value must be less than the `cellAppLoadUpperBound`.

  See also option `cellAppLoadUpperBound`.

- **`cellAppLoadSafetyBound` (Float)**

Limit that the load balancing can increase a cell's load to.

This value has to be greater than cellAppLoadUpperBound.

In some situations, such as adding a new cell, some cells may have their load temporarily increased.

- **`cellAppLoadSafetyRatio` (Float)**

  Cell's average load safety ratio.

  When the average load of the cells in a space is high, the limit that the load balancing can safely increase a cell's load to is calculated by multiplying this value by the average load. The real boundary is calculated as:

  max(cellAppLoadSafetyRatio, avgCellAppLoad * cellAppLoadSafetyRatio)

- **`cellAppLoadUpperBound` (Float)**

  Minimum average load that a CellApp must achieve before a new cell is considered to be required.

  This value is a fraction, and its range is 0.0 through 1.0.

  Too low an upper bound will waste CPU, but too high an upper bound could potentially allow a CPU spike to kill a CellApp.

  This value must be greater than the `cellAppLoadLowerBound`.

  See also option `cellAppLoadLowerBound`.

- **`cellAppLoadWarningLevel` (Float)**

  Minimum value that average load of CellApps must achieve (when there are no other CellApps available to share the load) before warning messages are sent to the log.

- **`cellAppOverloadLevel` (Float)**

  Minimum load level that any CellApp should reach for the system to be considered in overload, and thus reject new logins.

  Similar overload levels are specified for all BaseApps (by option `<baseAppOverloadLevel>` - for details, see “BaseAppMgr Configuration Options” on page 22), and for DBMgr (by option `<overloadLevel>` - for details, see “DBMgr Configuration Options” on page 35).

- **`cellAppTimeout` (Float)**

  Number of seconds for a CellApp to respond before it is considered dead.

- **`hardKillDeadCellApps` (Boolean)**

  Determines if a non-responsive CellApp will be terminated with a SIGQUIT signal.

  CellApp non-responsiveness is determined by cellAppTimeout option.

  It is important to terminate the non-responsive CellApp, in order to prevent duplicate entities, since some of the entities on the non-responsive CellApp will be recreated on neighbouring CellApps (for details, see “CellApp Fault Tolerance” on page 86).

  When this option is set to false, no signal will be sent to the non-responsive CellApp. This option should only be used for debugging purposes, *e.g.*, to attach a debugger to the hung process.

- **`internalInterface`**

For details, see “General Configuration Options” on page 7 .

This tag is deprecated, and its use is not recommended. For details, see the document Server Overview's section Server Components, BWMachined, BWMachined interface discovery.

- **`internalLatencyMax`**

  For details, see “General Configuration Options” on page 7 .

- **`internalLatencyMin`**

  For details, see “General Configuration Options” on page 7 .

- **`internalLossRatio`**

  For details, see “General Configuration Options” on page 7 .

- **`loadBalancePeriod` (Float)**

  Number of seconds between adjustments of the cell boundaries to improve the load balance on CellApps.

- **`loadSmoothingBias` (Float)**

  Value to smooth the load changes on a component by when calculating new load.

  The BigWorld server uses the load on a component to perform its load balancing. Unfiltered, the load can change too quickly to be useful. The option `loadSmoothingBias` is used to smooth out this value.

  The filtered value is calculated at each game tick as follows:

  ```
  newSmoothedLoad = (1 - loadSmoothingBias) * oldSmoothedLoad + loadSmoothingBias
  * load
  ```

  The CellAppMgr further smooths the CellApp loads when it is informed of them.

  This option is also available for BaseApps and CellApps.

- **`maxLoadingCells` (Integer)**

  Maximum number of cells that the meta-load balancing will try to add to a space to help it initially load its geometry.

  To disable this feature, set this value to 0.

- **`metaLoadBalancePeriod` (Float)**

  Number of seconds between checking whether any cells should be added to or removed from any spaces to improve the load balance on CellApps.

- **`minLoadingArea` (Integer)**

  Minimum average area (in square metres) that the cells in a space must have for it to be added by the meta-load balancing when attempting to initially load the geometry of a space.

  If the average area is less than this value, then no more cells will be added to the meta-load balancing - this is meant to prevent too many cells being allocated to small spaces.

- **`overloadTolerancePeriod` (Float)**

  Number of seconds that logins will be accepted during a situation where the CellApps are overloaded (see the `cellAppOverloadLevel` option). After this period of time, any further logins will be rejected.

- **`shouldLimitBalanceToChunks` (Boolean)**

  Determines if the loaded chunks of cells should be considered when load balancing.

  This is enabled by default, so that load balancing will not cause a cell to cover an area that has not yet been loaded.

2.12. DBMgr Configuration Options

The DBMgr configuration options are specified in file `<res>/server/bw.xml` under the section `<dbMgr>`, and are described below:

- **`allowEmptyDigest` (Boolean)**

  Flag indicating whether DBMgr should allow clients to log in with an empty MD5 digest.

  When a client logs in, an MD5 digest of the entity definitions is sent to the server. This is to ensure that the client is using resources consistent with the server's.

  This should be true if you are using egclient or bots to log in, since those programs do not read the entity definition files (named `<res>/scripts/entity_defs/<entity>.def`).

- **`backupDatabases` (List)**

  Only valid when the MySQL database layer is used.

  Each element in the list describes a backup database to use in case the primary database fails. The format of this list is:

```
<label>
  <host>     hostname      </host>
  <username> username      </username>
  <password> password      </password>
  <databaseName>     database_name </databaseName>
</label>
```

  For details on each tag, see `host`, `username`, `password` and `databaseName` configuration options in this table.

  If one of the above tags is not specified, then the backup database is assumed to be the same as the primary one. `<label>` can be any valid XML tag, and is currently purely cosmetic.

  DBMgr immediately switches to a backup database when the connection to the primary database unexpectedly fails. It assumes that the backup database is an up-to-date replica of the primary one. Database replication must be set up manually prior to using DBMgr's automatic fail-over feature.

  If multiple backup databases are specified, then DBMgr connects to them in the order specified in the configuration. If the last backup database fails, then DBMgr tries to connect to the primary database again. And so on.

  EXAMPLE:

  The example below configures two backup databases. Since `username`, `password`, and `name` of the second backup database are omitted, they are inherited from the primary database - *i.e.*, `username` is `biguser`, `password` is `bigpwd`, and `databaseName` is `fantasydemo`.

```
<dbMgr>
  <host>     dbnode01    </host>
```

```
  <username> biguser     </username>
  <password> bigpwd      </password>
  <databaseName>     fantasydemo </databaseName>
  <backupDatabases>
    <backup>
      <host>     dbnode02    </host>
      <username> bckpuser    </username>
      <password> bckpusrpass </password>
      <databaseName>     fantasy_bkp </databaseName>
    </backup>
    <anotherBackup>
      <host> dbnode03 </host>
    </anotherBackup>
  </backupDatabases>
</dbMgr>
```

- **`clearRecoveryData` (Boolean)**

  Flag indicating whether the previous state of the server should be cleared from the database.

  If set to true, then the previous state of the server is cleared from the database, and is not loaded.

  If set to false, then the previous state of the server is loaded from the database.

- **`createUnknown` (Boolean)**

  If `true`, a user can log in with an unknown login name and a new entity of type specified in `entityType` will be created. If `loadUnknown` is also `true`, a new entity is created only if an existing entity is not found.

  See also options `entityType`, `loadUnknown` and `rememberUnknown`.

- **`databaseName`**

  Only valid when the MySQL database layer is used.

  Name of the underlying database to use.

- **`dumpEntityDescription` (Integer)**

  Level of logging information generated when loading entity definition files (named `<res>/scripts/entity_defs/<entity>.def`).

  The possible values are described in the list below:

  - **0** - No log is generated.
  - **1** - Brief details about the entity are generated.
  - **2** - Full listing of entity is generated.

- **`entityType` (String)**

  Type of entity to create when client logs in with an unknown name.

  This option only has effect if option `createUnknown` is set to `true`.

  See also option `createUnknown`.

- **`host` (String)**

  Only valid when the MySQL database layer is used.

Machine where the database is running.

The localhost identified can be used to refer to the current machine.

- **`internalInterface`**

  For details, see "General Configuration Options" on page 7 .

  This tag is deprecated, and its use is not recommended. For details, see the document Server Overview's section Server Components, BWMachined, BWMachined interface discovery.

- **`internalLatencyMax`**

  For details, see "General Configuration Options" on page 7 .

- **`internalLatencyMin`**

  For details, see "General Configuration Options" on page 7 .

- **`internalLossRatio`**

  For details, see "General Configuration Options" on page 7 .

- **`loadUnknown` (Boolean)**

  Flag indicating whether a user can log in with an unknown name if there is an entity of type specified in `entityType` with the same name as the `Username`.

  See also options `entityType`, `createUnknown`, and `rememberUnknown`.

- **`maxSpaceDataSize` (Integer)**

  Only valid when the MySQL database layer is used.

  The maximum size (in bytes) of space data that can be written to the database. The maximum value is 16MB.

  See also the CellAppMgr option `archiveSpaceData`.

- **`name` (String)**

  This tag is deprecated, and its use is not recommended. Use databaseName instead.

- **`numConnections` (Integer)**

  Only valid when the MySQL database layer is used.

  Number of connections to make to the underlying database.

  This must be greater than or equal to 1. The default is 5.

- **`overloadLevel` (Float)**

  Minimum load level that DBMgr should reach for the system to be considered in overload, and thus reject new logins.

  Similar overload levels are specified for all BaseApp's (using `baseAppOverloadLevel` - for details, see "BaseAppMgr Configuration Options" on page 22), and for any CellApp (using `cellAppOverloadLevel` - for details, see "CellAppMgr Configuration Options" on page 32 .

- **`overloadTolerancePeriod` (Float)**

Number of seconds that logins will be accepted during a situation where the CellApps are overloaded (see the `overloadLevel` option). After this period of time, any further logins will be rejected.

- **`Password` (String)**

  Only valid when the MySQL database layer is used.

  Password to be used when the DBMgr connects to the underlying database.

- **`port` (String)**

  Only valid when the MySQL database layer is used.

  Port to be used when the DBMgr connects to the underlying database. Set it to 0 to use the MySQL default port.

- **`rememberUnknown` (Boolean)**

  Only valid when the MySQL database layer is used.

  Flag indicating whether unknown users allowed to log in (due to `createUnknown` or `loadUnknown` options being `true`) will be stored in the database so that future logins by the same user will no longer be unknown.

  See also options `createUnknown` and `loadUnknown`.

- **`syncTablesToDefs` (Boolean)**

  Flag indicating whether changes to entity definition should be replicated to the MYSQL database.

  The possible values are described below:

  - **`false`**

    No changes will be made to MySQL database structure.

  - **`true`**

    Make all necessary changes to the database structure to match the entity definitions. This includes deleting redundant columns and tables.

  DBMgr will fail to start if the database structure does not exactly match the entity definitions.

  This option is intended to help prevent accidental deletion of data in case there are unintended changes to the entity definitions.

  It is recommended to set this option to a safe mode (*i.e.*, false), then manually update the MySQL database structure by running DBMgr with the command line option `--sync-tables-to-defs`.

- **`type` (String)**

  Type of database to use. Current options are: `xml` and `mysql`.

- **`username` (String)**

  Only valid when the MySQL database layer is used.

  Username used when the DBMgr connects to the underlying database.

- **`writePythonLog` (Boolean)**

Flag indicating whether to write the output of Python scripts to the local log file `<game_executable_folder>/python.log`.

This should generally be set to false, since the data is sent to the central logger anyway, and the disk I/O generated by logging could block the process.

This option is also available for CellApps.

2.12.1. Data Consolidation Options

The options for data consolidation tool are located in the `<dbMgr>/<consolidation>` section of the server configuration file `<res>/server/bw.xml`

For more detail about the data consolidation process, see "Data Consolidation Tool" on page 95).

- **`directory` (String)**

  Directory where the data consolidation tool puts temporary secondary database files copied from BaseApp machines. These files are automatically deleted when the data consolidation process completes.

  If the first character of the path is a `/` character, the path is treated as an absolute path. Otherwise, the path is treated as relative to the first `<res>` path that contains the directory.

2.13. LoginApp Configuration Options

The LoginApp configuration options are specified in file `<res>/server/bw.xml` under the section `<loginApp>`, and are described below:

- **`allowLogin` (Boolean)**

  Flag indicating whether login attempts should be accepted.

  This is useful when the server needs to be started without accepting logins for a while (*e.g.*, to have the server load chunks before allowing logins).

  Logins can be enabled by setting `allowLogin` watcher on each LoginApp to `true` - for a simpler way to achieve this for all running LoginApps, see `control_cluster.py`'s `set` command (for details on `control_cluster.py`, see "`control_cluster.py`" on page 67).

- **`allowProbe` (Boolean)**

  Flag indicating whether login probes should be accepted.

  It is recommended to have this flag set to `false` for servers running on the public Internet.

  This setting can be changed at runtime by settings the `allowProbe` watcher.

  See also option `logProbes`.

- **`allowUnencryptedLogins` (Boolean)**

  Flag indicating whether a client sending a plaintext login request and/or a null session key should be allowed to connect.

  This flag should only be used for testing purposes. Setting this flag to true on a production system is not recommended.

- **`externalAddress` (String)**

  Address to be returned to client if he is outside the server cluster LAN.

If the client is outside the server cluster LAN (the option localNetMask is used to determine that), then LoginApp will return the IP address set in this option, instead of the address that the BaseApp thinks it is on.

This option is intended for use only during development, when the machines that the BaseApps are running on do not have real IP addresses (*i.e.*, they are behind a NAT'ing firewall), but you still want clients to log in from the Internet.

See also option `localNetMask`.

- **`externalInterface`**

  For details, see "General Configuration Options" on page 7 .

- **`externalLatencyMax`**

  For details, see "General Configuration Options" on page 7 .

- **`externalLatencyMin`**

  For details, see "General Configuration Options" on page 7 .

- **`externalLossRatio`**

  For details, see "General Configuration Options" on page 7 .

- **`internalInterface`**

  For details, see "General Configuration Options" on page 7 .

  This tag is deprecated, and its use is not recommended. For details, see the document Server Overview's section Server Components, BWMachined, BWMachined interface discovery.

- **`internalLatencyMax`**

  For details, see "General Configuration Options" on page 7 .

- **`internalLatencyMin`**

  For details, see "General Configuration Options" on page 7 .

- **`internalLossRatio`**

  For details, see "General Configuration Options" on page 7 .

- **`localNetMask` (String)**

  Mask to be used against the client's IP address in order to determine whether he is inside the server cluster LAN.

  The net mask is an IP address followed by the number of bits to match. For example, `10.0.0.0/8` would match any IP starting with 10 (*i.e.*, `10.*.*.*`). The default is `0.0.0.0/0`, in which case no redirecting will be done.

  If it is determined that the client is not on the server cluster LAN, the LoginApp will return the IP address set in option externalAddress.

  See also option `externalAddress`.

- **`loginRateLimit` (Integer)**

Specifies the number of allowed logins when rate-limiting. As many logins as this are allowed during each rate-limiting period as specified in option `rateLimitDuration`.

For example, if option `loginRateLimit` is set to 100, and option `rateLimitDuration` is set to 10, then 100 logins will be allowed every 10 seconds. If the login rate limit quota is exceeded during this period, no further logins are allowed until the start of the next 10 second period.

See also option `rateLimitDuration`.

- **`logProbes` (Boolean)**

  Flag indicating whether login probe attempts should generate a log message.

  This might be useful for servers running on the public Internet, to verify users who are attempting to probe and/or hack the server.

  See also option `allowProbe`.

- **`port` (Integer)**

  Port that the LoginApp should listen to for login requests.

  If set to zero, then a random port is chosen, which is useful when running multiple BigWorld server instances in a LAN. The client would then need to auto-detect the available servers. For more details, see “Auto-Detection of LoginApps” on page 113 .

  Note: This option can be overridden when starting LoginApp with the command-line

  ```
  -loginPort n
  ```

- **`privateKey` (String)**

  This is the filename to read the LoginApp's RSA private key from. This is the key that is used to decrypt the client's login credentials.

  Please see Encrypting Client-Server Traffic for more information about the encryption support in BigWorld.

- **`rateLimitDuration` (Integer)**

  Specifies the rate-limiting time period in seconds. As many logins as is specified in option `loginRateLimit` are allowed during every one of these periods.

  For example, if option `loginRateLimit` is set to 100, and option `rateLimitDuration` is set to 10, then 100 logins will be allowed every 10 seconds. If the login rate limit quota is exceeded during this period, no further logins are allowed until the start of the next 10 second period.

  Setting this value to 0 disables login rate limiting.

  See also option `loginRateLimit`.

- **`registerExternalInterface` (Boolean)**

  If set to true, the LoginApp's external interface will be registered with bwmachined. This may be useful during development to allow clients to discover running server. This should be set to false in a production environment.

- **`shouldShutDownIfPortUsed` (Boolean)**

Flag indicating whether the LoginApp should shut down if the specified port to listen to is not available.

If set to true, the LoginApp will shut down if the specified port to listen to is not available. If set to false, the LoginApp will find another port to listen to.

See also option `port`.

- **`shutDownSystemOnExit` (Boolean)**

  Flag indicating whether the server should be also shut down when LoginApp is shut down.

  If set to `true`, then a controlled shutdown is performed on the server.

- **`verboseExternalNub` (Boolean)**

  Flag indicating whether to generate verbose log output related to external network traffic.

  What is verbose about it? what should they expect to see and why would they want to use it

2.14. Reviver Configuration Options

The Reviver configuration options are specified in file `<res>/server/bw.xml` under the reviver section, and are described below:

- **`internalLatencyMax`**

  For details, see “General Configuration Options” on page 7 .

- **`internalLatencyMin`**

  For details, see “General Configuration Options” on page 7 .

- **`internalLossRatio`**

  For details, see “General Configuration Options” on page 7 .

- **`pingPeriod` (Float)**

  Number of seconds between pings sent to monitored processes for execution check purposes.

  Reviver's monitor processes periodically by pinging them to check that they are still running and functioning normally.

  See also option `subjectTimeout`.

- **`reattachPeriod` (Float)**

  Number of seconds between each time that Reviver checks processes to determine if it can monitor them.

  If another Reviver stops monitoring a process, this option allows this Reviver to start monitoring that process.

  See also option `subjectTimeout`.

- **`shutDownOnRevive` (Boolean)**

  Flag indicating whether the Reviver itself should be shut down after reviving a monitored process.

  This is usually set to `true`, since once a Reviver has started a process, that machine should probably be considered busy.

See also option `subjectTimeout`.

- **`subjectTimeout` (Float)**

  Number of seconds that a monitored process will wait for a response from its current Reviver before accepting to be monitored by another one.

  If a monitored process does not receive a response from its current Reviver, then it is assumed that the Reviver has been stopped after reviving another one of its monitored processes (this behaviour is set by option `shutDownOnRevive`).

  See also options `pingPeriod`, `reattachPeriod` and `shutDownOnRevive`.

- **`timeoutInPings` (Integer)**

  Number of pings that can be missed by a monitored process before Reviver assumes it is dead.

2.14.1. Reviver's BaseAppMgr Configuration Options

The BaseAppMgr configuration options are specified in file `<res>/server/bw.xml` under section `<reviver>/<baseAppMgr>`. These are the same as general Reviver options, but specific to BaseAppMgr. If the setting is not specified, then the general one is used. For details on these options, see “Reviver Configuration Options” on page 42 .

The options are listed below:

- **`pingPeriod` (Float)**
- **`subjectTimeout` (Float)**
- **`timeoutInPings` (Integer)**

2.14.2. Reviver's CellAppMgr Configuration Options

The CellAppMgr configuration options are specified in file `<res>/server/bw.xml` under section `<reviver>/<cellAppMgr>`. These are the same as general Reviver options, but specific to CellAppMgr. If the setting is not specified, then the general one is used. For details on these options, see “Reviver Configuration Options” on page 42 .

The options are listed below:

- **`pingPeriod` (Float)**
- **`subjectTimeout` (Float)**
- **`timeoutInPings` (Integer)**

2.14.3. Reviver's DBMgr Configuration Options

The DBMgr configuration options are specified in file `<res>/server/bw.xml` under section `<reviver>/<dbMgr>`. These are the same as general Reviver options, but specific to DBMgr. If the setting is not specified, then the general one is used. For details on these options, see “Reviver Configuration Options” on page 42 .

The options are listed below:

- **`pingPeriod` (Float)**
- **`subjectTimeout` (Float)**

- **`timeoutInPings` (Integer)**

2.14.4. Reviver's LoginApp Configuration Options

The LoginApp configuration options are specified in file `<res>/server/bw.xml` under section `<reviver>/<loginApp>`. These are the same as general Reviver options, but specific to LoginApp. If the setting is not specified, then the general one is used. For details on these options, see "Reviver Configuration Options" on page 42 .

The options are listed below:

- **`pingPeriod` (Float)**
- **`subjectTimeout` (Float)**
- **`timeoutInPings` (Integer)**

Chapter 3. Admin Tools

A variety of tools are provided to assist in managing the BigWorld server. Broadly, these fall into four categories:

- **WebConsole** (See "WebConsole" on page 45 .)
- **Logger daemons** (See "Logger Daemons" on page 50 .)
- **Server command-line utilities (e.g., `control_cluster.py`)** (See "Server Command-Line Utilities" on page 67 .)
- **Standard GUI applications (e.g., SpaceViewer and BWPanel)** (See "Standard GUI Applications" on page 70 .)

The server tools are implemented almost entirely in Python, and can be easily extended by any customer, if additional functionality is desired.

BigWorld 1.8 moved most of the server tools functionality into the new WebConsole, in order to improve and unify the server toolset and simplify server administration for remote users and non-programmers (*e.g.*, artists, game designers, etc.) that may need to run and administer servers. Functionality formerly provided by tools such as ServerViewer, GMeter, watcher, and bw_log_viewer.cgi has been consolidated under WebConsole's single easy-to-use web interface.

Almost all server tool functionality is still available via command-line utilities, which is useful when only system console access is available (*e.g.*, when remotely administering a server cluster via ssh).

Where possible, documentation for the server tools is maintained as online help. For WebConsole, this means the Help link displayed in the navigation menu for each module. For command-line utilities, help is available via the --help switch.

This chapter provides an overview of the suite of tools available. For detailed documentation, however, please refer to the online help.

3.1. WebConsole

Located under `bigworld/tools/server/web_console` folder, WebConsole provides a simple web interface to manage and monitor a BigWorld server. For details on how to install and run WebConsole, see the document Server Tools Installation Guide.

Complete documentation for each WebConsole module is provided as online help, accessible as a link on the left hand side of the WebConsole page.

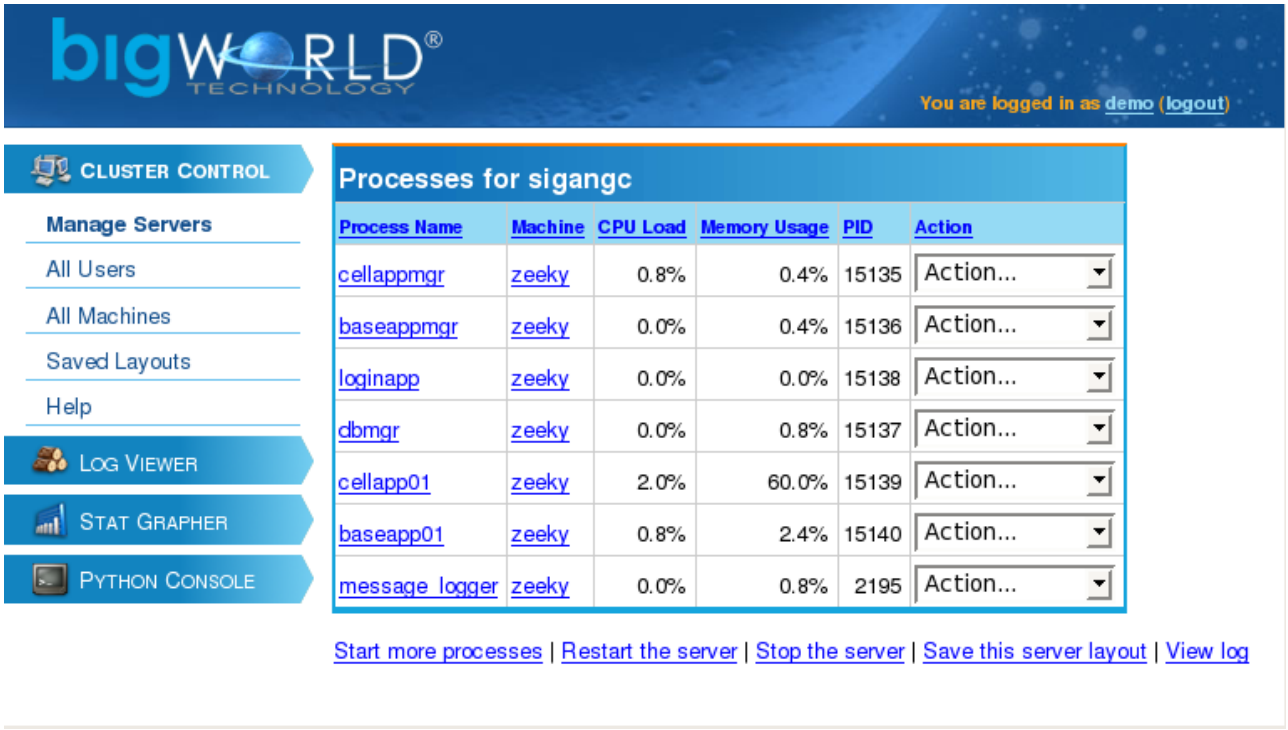
WebConsole consolidates functionality that was provided by a number of discrete tools BigWorld releases prior to 1.8, and is composed of the modules described below.

3.1.1. Modules

3.1.1.1. ClusterControl

- Allows users to start, stop, and restart the game server.
- Can browse the active machines and users on the local network.
- Can inspect the watcher tree of any running process.

- Can establish a connection to a BigWorld process's Python server.



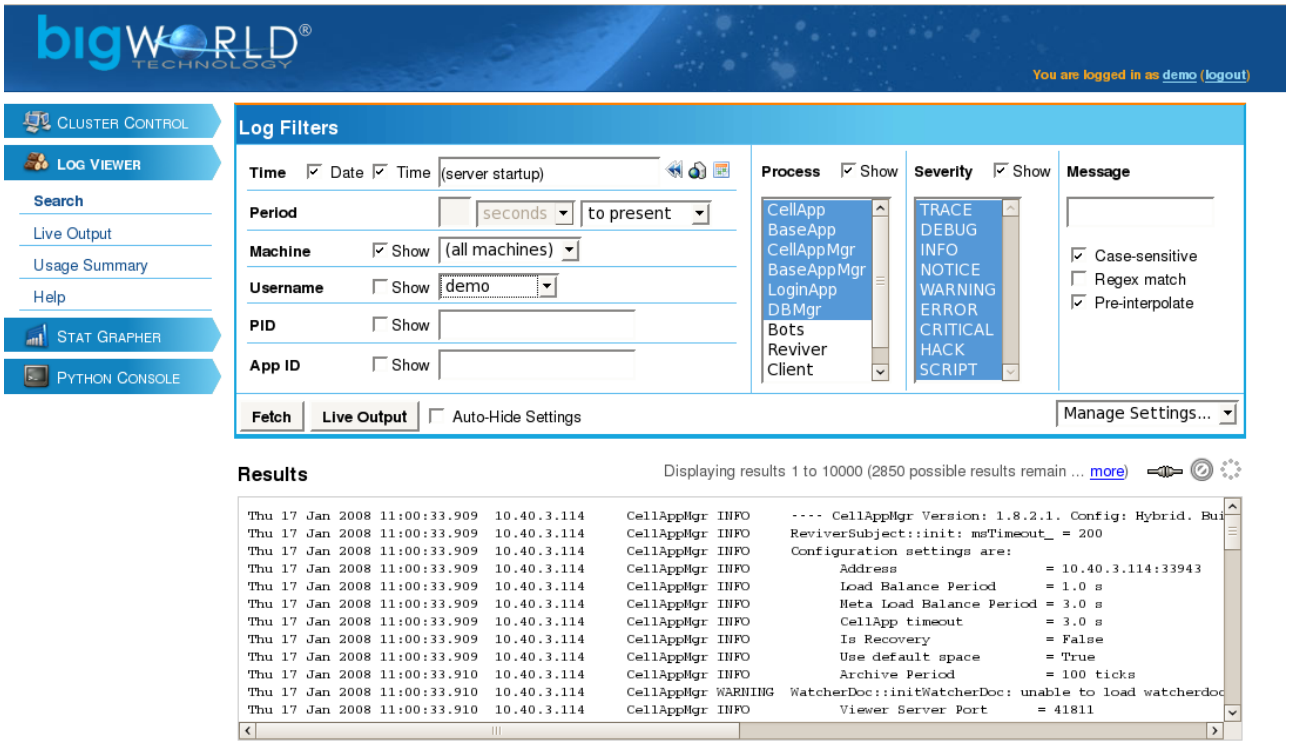
ClusterControl module

Note

This module replaces Server Viewer, Watcher, and some parts of BWPanel.

3.1.1.2. LogViewer

- Allows users to view, filter, and search server message logs.
- Provides a live view of server output, similar to calling `tail -f` on a logfile.
- Provides summaries of per-user log usage.



LogViewer module

Note
This module replaces bw_log_viewer.cgi.

3.1.1.3. StatGrapher

- Provides live and historic graphic views of server statistics.

StatGrapher module

Note

This module replaces GMeter.

3.1.1.4. Python Console

- Allows users to connect to the Python server of any process that has one (*i.e.*, CellApp, BaseApp, Bots).

Python Console module

3.1.2. Configuration

When the server tools are installed using the `install_tools.py` script (for details, see the document Server Tools Installation Guide), a system-wide configuration file (`/etc/bigworld.conf`) is used to locate tool components/tool configuration files and environment settings needed to run the server tools.

The primary user of this configuration file is the system startup/shutdown scripts installed into /etc/init.d. However, server tools such as MessageLogger may use this file to locate a working environment, if no appropriate command-line options are provided.

The format of the configuration file is in a Windows INI style format — comments may be provided by preceding them with the # (pound sign) or `;` (semicolon) characters.

The keywords in the `/etc/bigworld.conf` are described in the list below:

- **`username`**

  Username that maps to a valid system account. All server tool daemon processes will be run as this user.

- **`groupname`**

  Group that should own all server tools.

- **`piddir`**

  Folder on which server tools running in daemon mode should write their .pid files with their process ID. This file is used to later identify whether that daemon process is running, and if so, what system process it is. Most system daemons write their .pid files to /var/run or one of its sub-folders. The default folder for the BigWorld server tools `.pid` files is `/var/run/bigworld`.

- **`location`**

  Base folder of the server tools. Used by the system initialisation scripts, in order to be able to launch the server tools. Within a normal BigWorld package/checkout, this would refer to *`[prefix]`*`/mf/bigworld/tools/server`. For a server installation, it is recommended that this folder is located within the home directory of the user username.

Below is an example `/etc/bigworld.conf` configuration file:

```
[tools]
username = bwtools
piddir = /var/run/bigworld
location = /home/bwtools/mf/bigworld/tools/server
groupname = bwtools
```

Example `/etc/bigworld/conf`

A sample configuration file can also be found in `bigworld/tools/server/install/ bigworld.conf`.

3.1.3. How to Start

WebConsole can be started using two methods:

- As a system daemon — for details, see the document Server Tools Installation Guide's section Post-Installation.
- From the command line.

Generally, only developers working on modifying the web page templates or underlying code will run WebConsole in this fashion.

Make sure that the current folder is `bigworld/tools/server/web_console`, then issue the command:

```
./start-web_console.py
```

There are some minor operational differences when running WebConsole in the two mentioned modes:

- When run as a system daemon, WebConsole uses the configuration file `prod.cfg`, which defines a production environment mode.
- When run from the command line, WebConsole uses a development environment configuration file called `dev.cfg`.

Running in development mode leaves the web server in a state where an automatic restart is triggered if there are any changes to the template files or Python code it is using.

The production configuration file does not exist by default in `bigworld/tools/server/ web_console`, as it is partially generated during the installation process while using the `install_tools.py` script. The original production configuration file that the installation script uses is `bigworld/tools/server/install/web_console.cfg`.

Both configuration files need to specify the database to use. Before running WebConsole, make sure that the appropriate configuration file has a line that looks like this:

```
sqlobject.dburi="notrans_mysql://username:password@localhost:3306/
bw_web_console"
```

Specifying the database

To modify the `bigworld/tools/server/install/web_console.cfg` file to a working configuration file, replace the line:

```
###BW_SQLURI###
```

with an `sqlobject.dburi` line as indicated above.

For information regarding TurboGears configuration files and content, we recommend the TurboGears documentation website http://docs.turbogears.org/1.0/Configuration.

If you have never run WebConsole before and choose to run it from the command line (as opposed to installing the system service), it is necessary to create a database for WebConsole within MySQL. To do this, connect to your MySQL database using the username and password that you have defined in `dev.cfg`, then issue the following command:

```
CREATE DATABASE bw_web_console;
```

3.2. Logger Daemons

3.2.1. MessageLogger

MessageLogger replaces bwlogger as the server output logger — its source code is located in `bigworld/src/server/tools/message_logger`, while its executable and related Python tools and libraries are located in `bigworld/tools/server/message_logger`.

Detailed documentation for the supported command-line switches is available as online help, and can be viewed via the `--help` switch. This document provides an overview of how MessageLogger works, and the structure of the files it generates.

When a server process (*e.g.*, a CellApp) is started, it searches the cluster for all active MessageLogger processes, and proceeds to route to each discovered MessageLogger process all output generated by script calls to print, or calls to `INFO_MSG`, `ERROR_MSG`, etc.... MessageLogger processes that are started after a server process will notify all running server components of their existence, in order to start immediate logging.

The BigWorld Client can also be configured to send messages to the message logger. By default this is enabled in the Hybrid build and disabled in the Release build. The Consumer build has this controlled by a set of defines in `src/lib/cstdmf/config.hpp`.

The following defines should be enabled in Consumer to enable the client to send messages to the message logger:

```
#define FORCE_ENABLE_MSG_LOGGING     1
#define FORCE_ENABLE_DPRINTF         1
#define FORCE_ENABLE_WATCHERS        1
```

Messages from the client are by default sent to the `root` user. To send to a different user, set a UID environment variable for the user running client. The UID should be set to the numerical value of the user's Linux UID.

3.2.1.1. Configuration

Except where overridden by corresponding command-line options, MessageLogger reads its configuration from the file `message_logger.conf`, located in the same folder as the executable itself. An alternate configuration file can be specified on the command-line with the `-c/--config` switch.

The configuration file is in standard Windows INI file format, and supports the options:

- **`logdir`**

  The location of the top-level folder to which MessageLogger will write its logs. This option can be either a relative or an absolute path. If a relative path is specified, then it is calculated relative to the location of the configuration file — not relative to the folder current at the time of execution.

- **`segment_size`**

  Size (in bytes) at which the logger will automatically roll the current log segment for a particular user.

- **`default_archive`**

  File used by mltar.py when the `-d/--default_archive` switch is used. This file is also inserted into MessageLogger's logrotate script by `install_tools.py`.

3.2.1.2. File Format

MessageLogger generates files in binary format, but it supports the generation of text files (in the BigWorld 1.7 format) via the `--text` option. This option generates text files in addition to the binary files, in case you have tools that depend on the old logfile format.

Included in MessageLogger, along with the message_logger binary itself, are Python modules that provide an interface to this binary format:

- **`bwlog.so`** — A Python extension, compiled from MessageLogger source code
- **`message_log.py`** — Provides pure Python classes that simplify and extend the functionality exposed in `bwlog.so`.

For examples on how to use these modules, browse the source code of the command-line message logger utilities (`mlcat.py`, `mlls.py`, etc...) described in "Command-Line Utilities" on page 52 .

MessageLogger generates logs in a two-level folder structure — the top-level folder contains files that are common to all users, as well as one sub-folder per user. The files in the top-level folder are:

- **`component_names`**

  List of all distinct component names (*i.e.*, CellApp, BaseApp, etc...) that have sent messages to this logger. This is used to resolve numeric component type IDs to names, when displaying log output.

- **`hostnames`**

  Mapping from IP addresses to hostnames. This is used for resolving hostnames when displaying log output.

- **`strings`**

  List of all unique format strings that have been sent by server components, along with parser data for interpreting arguments to each. This is used to reconstruct the log messages from format string IDs and binary argument blobs.

- **`version`**

  Log format version. This is used to prevent accidental mixing two log formats.

- **`pid`**

  PID of active MessageLogger process. This is used by tools and MessageLogger to identify the process (if any) currently generating logs.

Each user's sub-folder has a file containing its UID, as well as the following files:

- **`components`**

  A record of each individual process instance registered with this logger.

- **`entries.<timestamp>`, `args.<timestamp>`**

  A segment of log messages. The fixed-length portion of each log message (time, component ID, etc...) is stored in the `entries.<timestamp>` file, while the variable-length portion of the entry (*i.e.*, arguments to printf) is stored in the corresponding `args.<timestamp>` file.

- **`text.<timestamp>`**

  BigWorld 1.7-compatible plain-text record of the log entries, from the corresponding `entries.<timestamp>/args.<timestamp>` pair. This file is generated if the `--text` option was specified.

3.2.1.3. Command-Line Utilities

The `bigworld/tools/server/message_logger` folder contains a variety of command-line utilities, providing the functionality of standard UNIX shell utilities for message logs. Using these utilities, you can operate on the binary logs using standard UNIX shell utilities and pipelines, in the same way you could with the old text format logs.

The following tools are provided:

- **`mlcat.py`**

  Provides both cat and `tail -f` style of text dumping of the logs.

- **`mlls.py`**

  Displays information about log segments, such as start and end times, entry counts, and sizes; for individual users or all of them.

- **`mltar.py`**

  Provides an easy way to select log segments from a user's log and archive them, as well as all the required shared files for viewing on another machine.

- **`mlrm.py`**

  Provides an easy way to clean up unwanted log segments.

The detailed documentation for each utility is maintained as online help, which can be accessed via the `--help` option.

The list below provides some common examples of tasks you might wish to achieve using the MessageLogger tools:

- **`mlcat.py -f`**

  Watches live server logs.

- **`mlcat.py --around="Mon 22 Jan 2007 19:00:00" -u devuser`**

  Views output surrounding a log entry of interest for user devuser.

- **`mltar.py -zcf bwsupport.tar.gz --active-segment`**

  Collects logs to email to support.

- **`mltar.py -u <uid> -zcf bwsupport.tar.gz --active-segment`**

  Collects logs for the Unix user whose uid is `uid` to email to support.

- **`mlls.py -u gameuser`**

  Displays all log segments for user gameuser, to determine the segment with entries of interest.

- **`mlrm.py --days=30`**

  Removes logs over a month old.

- **`mltar.py -xf lastweek.tar.gz -o samplelogs`**

  Extracts the archive lastweek.tar.bz2 to the folder samplelogs.

Note

Since the archives are compressed tar files, you can use tar to achieve the same results if you find that easier, as illustrated below:

```
$ mkdir samplelogs
$ tar -zxf lastweek.tar.gz -C samplelogs
```

- **`mltar.py -xd`**

  Extracts the latest archive back to the default logdir.

3.2.1.4. Configuration Options

The MessageLogger command-line options are described in the list below:

- **`-u UID`**

  UID of the user whose processes should be logged. If UID is all, then messages from all users will be logged. If no UID is specified, then processes by all users will be logged.

- **`-p NAME` (this option is mutually exclusive to `-d NAME`)**

  Name of the process which messages should be logged. Multiple names may be specified, using multiple `-p` options. By default, messages from processes of any name are logged. Appropriate names include: CellAppMgr, CellApp, BaseApp, BaseAppMgr, DBMgr, LoginApp, WPGen.

- **`-d NAME` (this option is mutually exclusive to `-p NAME`)**

  Name of the process which messages should not be logged. Multiple names may be specified, using multiple `-d` options. By default messages from processes of any name are logged.

- **`-l loggerID`**

  ID of the processes whose messages should be logged — value range is 0-255. The default is 0, a special value that causes logging all processes, regardless of loggerID.

- **`-v`**

  Prints all messages to standard output (verbose mode).

- **`--daemon`**

  Runs MessageLogger as daemon.

- **`-c|--config <file>`**

  Configuration file to use. The default is message_logger.conf in the MessageLogger folder. Option overridden by [outdir] option.

- **`-t|--text`**

  Generates BigWorld 1.7-style text logs, as well as binary logs.

- **`-q|--quiet`**

  Turns off the display of messages generated by the MessageLogger process (quiet mode). By default, these are output to standard error.

- **`-o filename`**

  Redirects standard output to filename.

- **`-e filename`**

  Redirects standard error to filename.

- **`-[TRACE|DEBUG|INFO|NOTICE|WARNING|ERROR|CRITICAL|HACK|SCRIPT]`**

  Disables logging of specific type of message.

- **`+[TRACE|DEBUG|INFO|NOTICE|WARNING|ERROR|CRITICAL|HACK|SCRIPT]`**

  Enables logging of specific type of message. The first option of this type disables logging of other messages.

- **[*outdir*]**

  Folder on which to write logs generated by MessageLogger. This option overrides any log folders specified in either the default configuration file, or any configuration file provided on the command line using the `-c` option.

3.2.1.5. Logrotate

`Logrotate` is used to rotate, archive, and delete old log files on a daily basis, which saves space on disk. A logrotate configuration file, `/etc/logrotate.d/bw_message_logger`, is set up as part of the Server Tools installation. For more information about `logrotate`, please see the `logrotate` manpage:

```
$ man 8 logrotate
```

There are two issues to consider when customising the `logrotate`:

- Log rotation can put a load on the logging machine.
- If rotation is configured to occur more frequently, for example the rotation is changed to occur on hourly basis, then in this case the `rotate` option should be updated to 168 (i.e. 7 x 24) to ensure that the log files cover the same period of time.

3.2.2. StatLogger

Written in Python, StatLogger is a daemon process that runs in the background, polling all servers on the network at regular intervals (by default, every 2 seconds). Any computer running BWMachined will be automatically discovered, along with any BigWorld components running on that machine. StatLogger collects and logs information for every server component discovered, regardless of which user is running them.

Statistics for machines and processes are collected in 2 ways:

- Communication with BWMachined daemons running on each computer.
- Requests made directly to the processes via the Watcher mechanism.

Once collected, StatLogger logs this data to a MySQL database. For details on the structure of the database, see “Statistics Database Structure” on page 66 .

The main objective of StatLogger is to collect and store data in a format that can be used by StatGrapher (for details, see “StatGrapher” on page 47), which is the visualisation counterpart to StatLogger, and presents the data in a graphical format. Together, StatLogger and StatGrapher are a replacement for the now defunct server tool GMeter.

3.2.2.1. Requirements

The list below describes the requirement for running StatLogger:

- **CPU**

  On an Athlon 2700+, monitoring 230 processes (which includes 200 CellApps) with StatLogger consumes roughly a constant 15% of available CPU time. The MySQL daemon will also be subject to load due to the large amount of database queries being generated — tests showed 5.5% of CPU time being used at a constant rate.

- **Disk**

  Due to the amount of data being collected, StatLogger can potentially consume a lot of disk space. The rate at which disk space is consumed depends on the amount of machines and server process for which

statistics are collected. 4GB is recommended for a large amount of processes (around 250) and machines over a month. The disk space consumption rate of a single log gets smaller the longer a log is run, since StatLogger stores older data in lower detail than newer data.

- **Network**

  StatLogger's network requirements depend on the number of server machines and components present. It can potentially require a large amount of network throughput. For example, 230 processes and 9 server machines require 100Kb/s of downstream traffic, and 20kb/s of upstream traffic, while 6 processes (*i.e.*, for a minimal server) and 9 server machines require 4kb/s of downstream and 2kb/s of upstream traffic.

- **RAM**

  Memory requirements are low, as statistics are immediately logged to the database, rather than being kept in memory. Tests indicate an average usage of memory between 7MB to 10MB, regardless of the amount of processes running.

- **Software**

  MySQL 4.1+ and Python 2.4 with MySQLdb (officially known as mysql-python, available at http://sourceforge.net/projects/mysql-python. It should be available as a package for every common Linux distribution)

Also, StatLogger must be run on the same local network as the servers. This is due to the machine and server component discovery, which only searches the local network.

StatLogger requires a valid MySQL user with access to create databases. Normally the creation and configuration of this MySQL user is handled during the tools installation script (for details, see the document Server Tools Installation Guide), but an existing database user can be can used instead, by manually editing the configuration file. For details, see “Configuration” on page 58 .

3.2.2.2. Installation

Located in `bigworld/tools/server/stat_logger`, the StatLogger script is part of the BigWorld package.

The tools installation script should be run before using StatLogger, as it performs the following actions:

1. Creates the MySQL user with the appropriate permissions for StatLogger, and sets the configuration file to use this user.
2. Installs init scripts into `/etc/init.d`, to enable running StatLogger as a daemon.

3.2.2.3. Usage

The script can be run from the command line, or it can be run in daemon mode with the use of a startup script created during the tool installation routine and placed in `/etc/init.d/bw_stat_logger`.

This script should be run as the root user, and can be run with the following actions:

- **`start`**

  Starts StatLogger.

- **`stop`**

  Stops StatLogger.

- **`restart`**

  Restarts StatLogger.

- **`status`**

  Shows the current status of StatLogger.

Although in most cases stat_logger.py will not need any arguments when run from the command line, it provides the following options

- **`-h --help`**

  Show script's help message.

- **`-f <pref_file> --config-file=<pref_file>`**

  Specifies a preference file to use instead of the default preferences.xml.

- **`-n <db_name> --database-name=<db_name>`**

  Specified the name of the database to use. If the database does not exist, then it will be automatically created, unless `-p` was specified. Note: If using an existing database, it is recommended to enable --use-db-prefs as well.

- **`-p --no-auto-create-db`**

  Prevents creation of a new log database under any circumstance.

- **`--pid=<pid_file>`**

  Daemon mode option. Although available for command-line use, the use of this type of option is recommended only for advanced users.

  Specifies location to store PID file.

- **`--use-db-prefs`**

  Retrieves and uses preferences from the log database being used (ignores preference file).

- **`-l --list`**

  Prints a list of log databases.

- **`-o <out_file> --output=<out_file>`**

  Logs file to dump message output (default is stdout).

- **`-e <out_file> --erroutput=<out_file>`**

  Logs file to dump error output (default is stderr).

- **`-d --daemon`**

  Runs StatLogger in daemon mode (default is to run in foreground).

- **`--winpdb`**

  Allow a Winpdb client to attach upon starting up. Winpdb is available at http://www.digitalpeers.com/pythondebugger.

- **`--home=<path>`**

  Daemon mode option. Although available for command-line use, the use of this type of option is recommended only for advanced users.

  Specifies home folder of StatLogger (default is bigworld/ tools/server/stat_logger).

3.2.2.4. Output

StatLogger outputs various status messages describing which machines and processes it discovers or loses (*i.e.*, from the process or machine shutting down) from the network, each prefixed with a timestamp.

When running StatLogger manually, it by default prints this information to the terminal in which it is run (unless the `-o` option is specified).

When installed as a daemon, these messages are output to /var/log/bigworld/ stat_logger.out by default.

3.2.2.5. Configuration

Located in StatLogger's folder, the preference file preferences.xml is used to configure the script. Apart from the database user configuration, in most cases the provided standard settings should be sufficient for development and production environments.

The preferences.xml file configures database setup options, as well as what data StatLogger should collect from the server components and machines.

The example below illustrates the basic structure of a configuration:

```
<preferences>
  <options>
  ...
  </options>

  <collect>
    ?<aggregation>
     ...
     </aggregation>

    ?<processList>
      *<process>
        ?<statisticList>
          *<statistic>
           ...

    ?<machineStatisticList>
      *<statistic>
       ...
       </statistic>
     </machineStatisticList>

    ?<allProcessStatisticList>
      *<statistic>
       ...
       </statistic>
     </allProcessStatisticList>
  </collect>

</preferences>
```

StatLogger's `preferences.xml` — Basic structure

3.2.2.5.1. Option Configuration

The options section contains the following tags:

- **`dbHost`**

  Hostname or IP address of the MySQL database server that will contain the log databases.

- **dbUser**

  Database user with which StatLogger (and StatGrapher) will access the database. For details on StatGrapher, see "StatGrapher" on page 47 .

- **dbPass**

  Database user's password.

- **dbPort**

  Port on which the MySQL server is listening for connections.

- **dbPrefix**

  Prefix of database names which StatLogger can accesses.

- **sampleTickInterval**

  Interval in seconds at which StatLogger will poll the components and store statistics — decimals are supported. Generally this value does not need to be changed — if it does, then it should not be any smaller than 2 seconds (the recommended value).

3.2.2.5.2. Aggregation Window Configuration

This collect/aggregation/window section configures the aggregation windows that will be stored in the database.

StatLogger has been designed so that it stores multiple versions of data at varying levels of detail — the idea is that long-term data does not need to be stored at the same level of detail as the more recent, short-term data.

StatLogger requires at least one aggregation window setting in this section with a samplePeriodTicks value of 1.

Multiple aggregation window setting takes the form of:

```
<preferences>
  ...
  <collect>
    <aggregation>
      *<window>
         <samples>           <num_samples_in_this_win>   </samples>
         <samplePeriodTicks> <num_of_ticks_per_sec>      </samplePeriodTicks>
       </window>
      ...
```

Multiple aggregation window settings — Grammar

There are some constraints that must be adhered to when creating this list of aggregation window settings:

- There must always be an aggregation window with samplePeriodTicks value of 1.
- Aggregation window settings must be ordered in ascending order by their samplePeriodTicks value, with the smallest values first.
- Each successive aggregation window should cover a larger range of ticks than the previous one. The tick range is calculated by multiplying samples value by the samplePeriodTicks value (*i.e.*, number of samples x ticks consolidated into one sample).
- Each successive samplePeriodTicks value must be a multiple of the samplePeriodTicks value from the previous window.

These aggregation windows are used directly by StatGrapher, so it is advised not to have large discrepancies between the samplePeriodTick values of successive aggregation windows. Furthermore, the final aggregation window setting should not have a large samples value, as this may place a very heavy load on StatGrapher, both on the server running WebConsole, as well as the Flash-based client.

An example aggregation section is shown below, with a samples value of 365:

```
<preferences>
  ...
  <collect>
    <aggregation>

      <!-- Every sample (2secs) in most recent 24hrs. 43200 samples -->
      <window>
        <samples>           43200 </samples>
        <samplePeriodTicks> 1     </samplePeriodTicks>
      </window>

      <!-- Every 10th sample (20secs) in most recent 48hrs. 8760samples -->
      <window>
        <samples>           8760  </samples>
        <samplePeriodTicks> 10    </samplePeriodTicks>
      </window>

      <!-- Every 150th sample (5mins) in most recent 30 days. 8760 samples -->
      <window>
        <samples>           8760  </samples>
        <samplePeriodTicks> 150   </samplePeriodTicks>
      </window>

      <!-- Every 1800th sample (60mins) in most rcnt 365 days. 8760 samples
 -->
      <window>
        <samples>           8760  </samples>
        <samplePeriodTicks> 1800  </samplePeriodTicks>
      </window>

      <!-- Every 43200th sample (1day) in most recent 365 days. 365 samples
 -->
      <window>
        <samples>           365   </samples>
        <samplePeriodTicks> 43200 </samplePeriodTicks>
      </window>
    </aggregation>
   ...
```

Multiple aggregation window settings — Example

3.2.2.5.3. Machine Statistic Configuration

The `collect/machineStatisticList` section is similar to `statisticList` (for details, see “Process Statistic Configuration” on page 61) and `allProcessStatisticList` (for details, see “Generic Process Statistic Configuration” on page 60) sections, except in that watcher values are not supported (since machines do not have a Watcher interface), and hence, the `valueAt` settings only support strings representing members of the `Machine` class defined in `bigworld/tools/ server/pycommon/cluster.py`.

3.2.2.5.4. Generic Process Statistic Configuration

The `collect/allProcessStatisticList` section is similar to the `statisticList` (for details, see “Process Statistic Configuration” on page 61) section, except in that its statistics are regarded as common

to all processes being monitored — *i.e.*, those specified in the `processList` section (for details, see "Process Configuration" on page 61).

It is recommended that any watcher values used in this section be supported by all processes being monitored, although StatLogger will store empty values for processes that do not support a watcher value.

3.2.2.5.5. Process Configuration

The `collect/processList/process` section configures the statistics that will be collected for each process — there must be one process section for each server component to be monitored

The process section contains the following tags:

- **`name`**

  Display name for the process type.

- **`matchtext`**

  Name of the component type's executable. Value must be in lowercase, like the executable names.

- **`statisticList`**

  List of statistics to be collected for this process by StatLogger — for details, see section "Process Statistic Configuration" on page 61 .

An example process section is shown below:

```
<preferences>
  ...
  <collect>
    ...
    <processList>
      <process>
        <name>      CellApp </name>
        <matchtext> cellapp </name>
        <statisticList>
          ...
        </statisticList>
      </process>
      ...
```

Process configuration — Example

3.2.2.5.6. Process Statistic Configuration

The collect/processList/process/statisticList/statistic section specifies the statistics that must be collected for each process.

The statistic section contains the following tags:

- **`name`**

  Display name for the statistic type.

- **`valueAt`**

  Where to retrieve the values from — there are two distinct sources of information, depending on the first character of this tag's value:

  If first character is a slash (/)

`valueAt` will be interpreted as a watcher. The best way to list the watchers that can be graphed is via the WebConsole's ClusterControl module (for details, see "ClusterControl" on page 45).

Any single scalar value present in ClusterControl can be added to StatGrapher (including any new ones that you have created yourself).

Example: `/stats/numInAoI`

If first character is not a slash (/)

Any `valueAt` string that does not begin with a slash is regarded as a Process class defined in script `bigworld/tools/server/pycommon/cluster.py`.

In this case, the string refers to the member of the `Process` class that StatLogger should retrieve. (Strictly speaking, `valueAt` is `eval`'ed against the Process object, which is slightly more flexible than just being able to reference class members).

Example: `mem` — This is `eval`'ed to `Process.mem`, which retrieves the value of memory usage of a process.

Note: Caution is required with this type of value, as it is possible to use a function call that changes the state of the process (*e.g.*, causing a process to shutdown). It is highly unlikely that this will occur by accident, unless the exact function call is entered in the `valueAt` setting.

- **`maxAt`**

  Not explicitly used in StatLogger — however it is used by StatGrapher to determine the scale of the graph.

  Note: For some watcher values (which are simply constantly increasing values with no upper bound), there is no appropriate `maxAt` value. In this case just set it to an arbitrary value, as these are not likely to be displayed in StatLogger.

- **`type`**

  Unused as of BigWorld 1.8.

- **`consolidate`**

  Consolidation function to use when moving data up an aggregation window.

  Possible values are: `MAX`, `MIN`, and `AVG`.

  Example: We consolidate four data samples at 4 seconds per sample into the next aggregation window, which stores data at 16 seconds per sample. The data represents CPU load consumed by a process. The `consolidate` value is specified as `AVG`, so StatLogger averages the four data samples, then store this value as a single value in the higher aggregation window.

- **`display`**

  Contains two tags that affect the appearance of the statistic in StatGrapher:

  - **`colour`** — Colour (in hexadecimal RGB) to represent this statistic in StatGrapher.
  - **`show`** — Sets whether StatGrapher shows this statistic by default. Possible values are true and false
  - **`description`** — Description of this statistic. This will be displayed in the tooltip when the user mouse over this statistic in the Legend section of the StatGrapher in the WebConsole.

An example statisticList section is shown below:

```
<preferences>
  ...
  <collect>
    ...
    <processList>
      <process>
        <name>      CellApp </name>
        <matchtext> cellapp </name>
        <statisticList>
          <statistic>
            <name>        Cell Load               </name>
            <valueAt>     /load                   </valueAt>
            <maxAt>       1.0                     </maxAt>
            <logicalMax>  None                    </logicalMax>
            <type>        FLOAT                   </type>
            <consolidate> AVG                     </consolidate>
            <display>
              <colour>    #FF6600                 </colour>
              <show>      true                    </show>
              <description>
                  The load of this CellApp.
              </description>
            </display>
          </statistic>
          <statistic>
            <name>        Num Entities Ever       </name>
            <valueAt>     /stats/totalEntitiesEver </valueAt>
            <maxAt>       10000.0                 </maxAt>
            <type>        FLOAT                   </type>
            <consolidate> MAX                     </consolidate>
            <display>
              <colour>    #663366                 </colour>
              <show>      false                   </show>
              <description>
                  The number of entities created on the CellApp since server
 startup.
              </description>
            </display>
          </statistic>
          <statistic>
            <name>        Process CPU             </name>
            <valueAt>     load                    </valueAt>
            <maxAt>       1.0                     </maxAt>
            <type>        FLOAT                   </type>
            <consolidate> AVG                     </consolidate>
            <display>
              <colour>    #FF0000                 </colour>
              <show>      true                    </show>
              <description>
                  The percentage of the CPU time allocated to the process.
              </description>
            </display>
          </statistic>
          ...
```

Process statistic configuration — Example

3.2.2.5.6.1. Useful Configuration Values for Processes and Machines

The table below lists some recommended values for process statistic configuration (for details, see “Generic Process Statistic Configuration” on page 60):

	<name>	<valueAt>	<max>
CellApp	Cell Load	/load	1.0
	Cell Spare Time	/nub/spare time	1.0
	Cell Backlog	/nub/receive queue	1048576
	Max Tick Period	/resetOnRead/ maxTickPeriod	0.2
	Num Entities	/stats/numEntities1	10000.0
	Num RealEntities	/stats/ numRealEntities	10000.0
	Num Witnesses	/stats/numWitnesses	10000.0
	Num Entities Ever	/stats/ totalEntitiesEver	10000.0
	Num RealEntities Ever	/stats/ totalRealEntitiesEver	10000.0
	Num Witnesses Ever	/stats/ totalWitnessesEver	10000.0
	Num In AoI	/stats/numInAoI	10000.0
	Num In AoI Ever	/stats/totalInAoIEver	10000.0
	Cell scale back	/throttle/value	1.0
BaseApp	BaseApp Load	/load	1.0
	Num Bases	/numBases	10000.0
	Num Proxies	/numProxies	10000.0
BaseAppMgr	Max BaseApp Load	/baseAppLoad/max	1.0
	Average BaseApp Load	/baseAppLoad/average	1.0
	Min BaseApp Load	/baseAppLoad/min	1.0
	Total Bases	/numBases	10000.0
	Total Proxies	/numProxies	10000.0
CellAppMgr	Max CellApp Load	/cellAppLoad/max	1.0
	Avg CellApp Load	/cellAppLoad/average	1.0
	Min CellApp Load	/cellAppLoad/min	1.0
	Total Entities	/numEntities	50000.0
	Number of Cells	/numCells	20
All processes	Process CPU	load	1.0
	Process Memory	mem	1.0

The table below lists some recommended values for machine statistic configuration:

	<name>	<valueAt>	<max>
Machines	Machine CPU	load()	1.0
	Machine Mem	mem	1.0
	Machine Recv Loss	inDiscards	256
	Machine Send Loss	outDiscards	256
	Packets In (eth0)	ifStats["eth0"].packIn	256
	Packets Out (eth0)	ifStats["eth0"].packOut	256
	Bits In (eth0)	ifStats["eth0"].bitsIn	256
	Bits Out (eth0)	ifStats["eth0"].bitsOut	256
	Packets In (eth1)	ifStats["eth1"].packIn	256
	Packets Out (eth1)	ifStats["eth1"].packOut	256
	Bits In (eth1)	ifStats["eth1"].bitsIn	256
	Bits Out (eth1)	ifStats["eth1"].bitsOut	256

3.2.2.5.7. Further Notes on Configuration

The configuration file directly affects the database structure used for storing the statistics. If the collect section of the configuration file is changed, then StatLogger will detect the change when it is next run, and will subsequently create a new statistics database from scratch, in order to accommodate the new structure.

3.2.2.6. Database

The sections below describe the databases used by StatLogger and the tables in the statistics database.

3.2.2.6.1. Naming and Creation

StatLogger might end up using many databases on the MySQL server, although the minimum required is two — one for actual statistics, and one for the meta-database that keeps track of all the statistics databases.

By default, the meta-database is named `bw_stat_log_info`, and contains a single table called `bw_stat_log_databases`, which holds the names of the statistics databases. The meta-database is always created if it does not exist in the MySQL server.

The statistics databases by default are named `bw_stat_log_data<n>`, where `<n>` is the incremental database number. However, users can choose to create statistics databases with specific names, using the `-n` option when running StatLogger — for details, see “Usage” on page 56 .

New statistics databases are created in the following situations:

- There are no statistics databases in the MySQL server.
- The preferences file was structurally changed, which causes a new statistic database to be created — for details on preferences.xml, see “Configuration” on page 58 .
- StatLogger was started with the `-n <database_name>` command-line option, and there was no statistic database with that name in the MySQL server.

Typically, only one statistics database will be needed once StatLogger has been properly configured. There is usually no need to arbitrarily create new statistics databases, unless isolated sets of statistics are needed (which might be the case when performing tests with the BigWorld server).

3.2.2.6.2. Statistics Database Structure

Below is an overview of the tables in a statistics database:

- **`pref_processes`**

  Process preferences specified in configuration file's collect/ processList section. For details, see “Process Configuration” on page 61 .

- **`pref_statistics`**

  Statistic preferences specified in configuration file.

- **`seen_machines`**

  Machines observed while StatLogger was running.

- **`seen_processes`**

  Processes observed while StatLogger was running.

- **`seen_users`**

  Users observed while StatLogger was running.

- **`stat_<proc>_lvl_<lvl>`**

  Statistics collected for processes of type `<proc>`, with `<lvl>` index of aggregation.

  Examples: `stat_baseapp_lvl_001`, `stat_cellapp_lvl_004`

- **`stat_machines_level_<lvl>`**

  Statistics collected for machines, with `<lvl>` index of aggregation — the higher the aggregation level, the lower the resolution of the data being stored in that table

- **`std_aggregation_windows`**

  Aggregation level details specified in configuration file's collect/aggregation section.

  For details, see “Aggregation Window Configuration” on page 59 .

- **`std_info`**

  Contains two pieces of information:

  - `sampleTickInterval` specified in the configuration file's options section — for details, see “Option Configuration” on page 58 .
  - Database structure version (internally used by StatLogger).

- **`std_session_times`**

  Start end times of when StatLogger was run.

- **`std_tick_times`**

  Timestamps of the start of each interval.

- **`std_touch_time`**

Last time the database was written to, in database local time.

Only used by StatGrapher (for details, see "StatGrapher" on page 47), whether StatLogger is currently logging to this database or not.

3.3. Server Command-Line Utilities

3.3.1. `control_cluster.py`

Located under `bigworld/tools/server`, this tool is used for managing a BigWorld cluster and the processes running on it.

For detailed information on actual usage, please see the online help (with the `--help` switch).

The options for invoking `control_cluster.py` are described in the list below:

- **`start`**

  Starts a server on the cluster.

  The set of machines to be used can be specified in a number of different ways.

- **`stop`**

  Stops a currently running server in the most controlled way possible.

- **`kill`**

  Forces shutdown of server components with `SIGINT`.

- **`nuke`**

  Forces shutdown of server components with `SIGQUIT`.

- **`restart`**

  Restarts the server. Same as running with stop option, and then with start option.

- **`startproc`**

  Starts a new server process.

- **`stopproc`**

  Stops a specific server process.

- **`nukeproc`**

  Kill a specific server process, and cause it to dump core.

- **`restartproc`**

  Restarts a specific server process.

- **`killproc`**

  Kills a specific server process.

- **`restartproc`**

Restarts a specific server process.

- **`display`**

  Displays information about the currently running server.

- **`summary`**

  Shows an abridged version of the display output.

- **`check`**

  Indicates whether a server is running.

- **`checklayout`**

  Indicates whether a server is running with a given layout.

- **`cinfo`**

  Displays information about the machines on the cluster that are running BWMachined.

- **`netinfo`**

  Show network statistics for a set of machines.

- **`users`**

  Displays information about users who are running server processes on the cluster.

- **`save`**

  Saves the current server layout to an XML file.

- **`load`**

  Starts the server according to a layout from an XML file.

- **`watch`**

  Queries watcher values from server processes. Also available under the command alias `get`.

- **`set`**

  Sets a watcher value on one or more processes.

- **`set`**

  Sets a watcher value on one or more processes.

- **`pyconsole`**

  Telnets to the Python server port on a server process.

- **`runscript`**

  Non-interactively run Python script on given processes.

- **`querytags`**

Queries BWMachined tags on the cluster.

- **mdlist**

  Displays a comma-separated list of machines on the network.

  This is useful for passing to pdsh (http://www.llnl.gov/linux/pdsh/pdsh.html) or similar utilities.

- **flush**

  Forces machines to flush their tag and user mappings.

- **checkring**

  Discovers the machined buddy ring, and verifies its correctness.

- **log**

  Sends a once-off log message to MessageLogger processes.

- **pyprofile**

  Print a report on Python profiling.

- **cprofile**

  Print a report on internal BigWorld profiling on processes.

- **eventprofile**

  Print a report on script method and data propagation profiling.

- **mercuryprofile**

  Print a report on per-message-type profile statistics from processes.

3.3.2. eload (Entity Loader)

The `eload` tool reads any entities from a file formatted as a `.chunk` file, and instantiates them on the base (or on the cell, if the `-cell` option is used). For details on the format of `.chunk` files, see the document Client Programming Guide's chapter Chunks.

Note

As of BigWorld 1.7, the purpose of eload (to automatically have the server load entities in the space) is supported by WorldEditor — hence this tool is deprecated.
There are two suggested methods for interactively loading entities on a running server:

- The `runscript` utility — for details, see "`runscript`" on page 70 .
- Calling a loading function on the server, using a Python telnet console — for details, see "`control_cluster.py`" on page 67 .

3.3.3. MessageLogger Related Utilities

For details on the tools available for interacting with server message logs, see "Command-Line Utilities" on page 52 .

3.3.4. mls (Machine List)

The tool `mls` lists all machines on the local network that are running BWMachined and processes registered with it.

Note

As of BigWorld 1.7, the functionality of mls and other utilities is provided by `control_cluster.py` (for details, see "`control_cluster.py`" on page 67).
The `mls` utility now exists primarily as an example of how to use the C++ side of the `MachineGuardMessage` API in `src/lib/ network/ machine_guard.[ch]pp` for talking to BWMachined.
This utility is no longer being actively developed, and should be considered deprecated.

3.3.5. runscript

The runscript executable is a simple server-side tool that interfaces with the cell and the base to execute arbitrary scripts for the management of a BigWorld server.

It is located in folder `bigworld/tools/server`, and has the following syntax:

```
runscript [-base|-cell [-space <spaceid>]] [-all] [script]
```

The options for invoking `run_script` are described in the list below:

- **`-h --help`**

  Displays command-line option help and exits.

- **`-base`**

  Executes the script on BaseApp. By default, the least loaded BaseApp is used.

- **`-cell`**

  Executes the script on CellApp. By default, the least loaded CellApp that has a space is used.

- **`-all`**

  Modifies the option `-base` or `-cell` default to execute the script on all BaseApps and CellApps.

- **`-space <spaceid>`**

  Modifies the option `-cell` to execute only on a cell (or cells) in the space specified.

Note

Most of this functionality is supported by `control_cluster.py`. `control_cluster.py` should be preferred over using this tool.

3.4. Standard GUI Applications

The section below described the following server GUI applications:

- BWPanel — See "BWPanel" on page 71 .
- Space Viewer — See "Space Viewer" on page 75 .

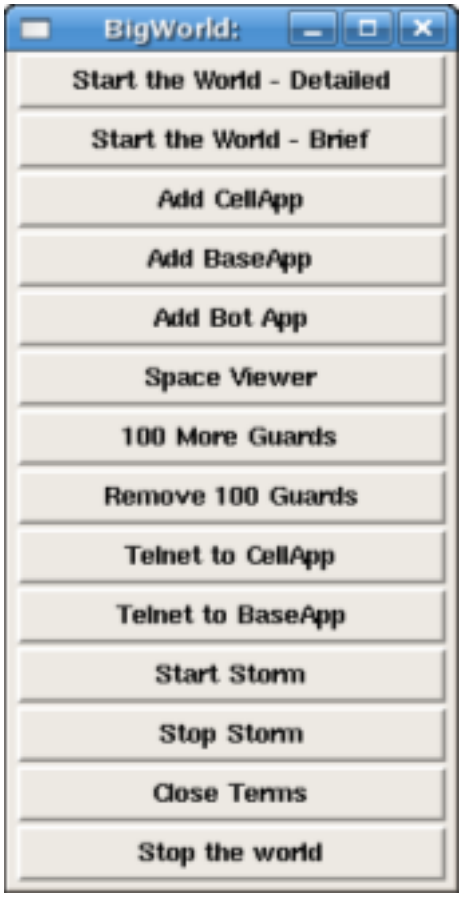
3.4.1. BWPanel

Note

As of BigWorld 1.9, BWPanel is deprecated. All interactions with the server (i.e. starting, stopping, interacting with watchers, calling python script etc) are expected to be done with either Web Console or the supported command-line utilities (`control_cluster.py` and `bot_op.py`). In particular, servers started with BWPanel will not set the timing method from the `[TimingMethod]` section in `/etc/bwmachined.conf`. You must manually export `BW_TIMING_METHOD` into your environment if you wish to use `gettimeofday` timing.

A simple way to control the server during development is by using the tool BWPanel. It is implemented as a simple script that displays a list of buttons, which allow you to run other scripts. It is quite easy to extend BWPanel with your own buttons, which are themselves just scripts.

Located on `bigworld/tools/server/bwpanel`, its main window is displayed below:



BWPanel's window

BWPanel is designed for running the server on a single machine during development. It is not designed for production use — for that purpose, use WebConsole (for details, see "WebConsole" on page 45) or `control_cluster.py` (for details, see "`control_cluster.py`" on page 67).

3.4.1.1. Standard Buttons on BWPanel

The buttons on BWPanel are listed on the table below:

- Start the world — Detailed

Starts on the local machine all components required for a server, each on its own terminal.

The components are started in the following order: CellAppMgr, BaseAppMgr, DBMgr, LoginApp, CellApp, and BaseApp.

- Start the world — Brief

  Starts on the local machine all components required for a server.

  It starts three terminals, as listed below:

  - **`world`** — DBMgr, CellAppMgr, BaseAppMgr, and LoginApp
  - **CellApp** — CellApp
  - **BaseApp** — BaseApp

  See also the Stop the World button .

- Add CellApp

  Starts a CellApp process.

  It starts an extra CellApp process for a single-machine server, which is useful for dual CPUs, or for testing multiple cells within a single machine.

  It can also start a CellApp by itself, on a separate machine that you wish to add to the server farm. To do this, run BWPanel under the same UID on another machine, and add a CellApp. The CellApp will register with the existing server, and start load balancing with the existing CellApps.

  The Python script `control_cluster.py` is a more convenient way to start CellApps on remote machines. For details, see “`control_cluster.py`” on page 67 .

  See also the Stop the World button.

- Add BaseApp

  Starts a BaseApp process on the local machine.

  Similarly to the mechanism of the Add CellApp button, the new BaseApp will join the rest of the system running on that UID.

  See also the Add CellApp and Stop the World buttons.

- Add Bot App

  Starts a Bot process on the local machine.

  Similarly to the mechanism of the Add CellApp button, the new Bot process will join the rest of the system running on that UID.

  See also the Add CellApp and Stop the World buttons.

- Space Viewer

  Launches the Space Viewer tool. For more details, see “Space Viewer” on page 75 .

- 100 More Guards

  This button is specific to FantasyDemo example world.

Adds 100 NPCs to the world.

These are very simple simulated players driven by AI server scripts to act like guards.

- Remove 100 Guards

  This button is specific to FantasyDemo example world.

  Removes 100 of the entities added by the 100 More Guards button.

- Telnet to CellApp

  Opens a terminal window with a prompt to Python on the CellApp's port.

- Telnet to BaseApp

  Opens a terminal window with a prompt to Python on the BaseApp's port.

- Start Storm

  This button is specific to FantasyDemo example world.

  Starts a thunderstorm in the world.

- Stop Storm

  This button is specific to FantasyDemo example world.

  Stops the thunderstorm in the world.

- Close Terms

  Closes all terminal windows associated with running the world.

  It is used in conjunction with the Stop the World button, which does not close the terminals.

  See also the Stop the World button.

- Stop the World

  Stops all components of the running BigWorld server started by the following buttons:

  - Start single-machine world
  - Add CellApp
  - Add BaseApp

  It does not stop BWMachined, which should be running all the time, nor tools such as the watcher process or GUI apps (Space Viewer, General Meter, etc...).

  The terminals are left open so that final output from the components can be examined.

  The Close Terms button closes the terminal windows associated with the world.

3.4.1.2. Adding Buttons to BWPanel

When launched, BWPanel reads all files with extension `.but` in its folder. These files are shell scripts, each defining a single button.

The code fragment below illustrates the implementation of the Display Details button by the `View_Info.but` file:

```
#!/bin/sh

#BWPANEL 2.5 'Display Details'

# start the cell up in a terminal.
$MF_ROOT/bigworld/tools/myscript.sh
```

Example `View_Info.but` file — Implementation of the **Display Details** button

As displayed in the example code above, the button definition file has the sections below:

- **Code interpreter**

  Program to use to run the script

- **Display information**

  Optional display information. The parameters are described in the list below:

  - **Button order**

    Floating-point specifying the order in which button is to be displayed.

    Button will not be displayed if value specified is not unique.

  - **Button label**

    Label to be displayed for the button.

    If you choose to not specify it, then it will be derived from the file name (underscores are converted to spaces, and the extension is dropped).

    In the example above, if `Display Details` was not specified, then the button would have been labelled `View Info` (the file name is `View_Info.but`)

- **Code**

  Code to be executed when button is clicked — the syntax is specific to whatever interpreter was chosen.

3.4.1.3. Command-Line Options

Located under the `bigworld/tools/server/bwpanel` folder, BWPanel can be called via command line with the following syntax:

```
bwpanel [-display display]
```

The options for bwpanel are interpreted by Tcl/Tk's wish command, and are described in the list below:

- **`-display display`**

  Specifies the display (and screen) on which to display window.

  The `display` argument specifies the X window on which to display instead of the one specified in the `DISPLAY` environment variable.

3.4.2. Space Viewer

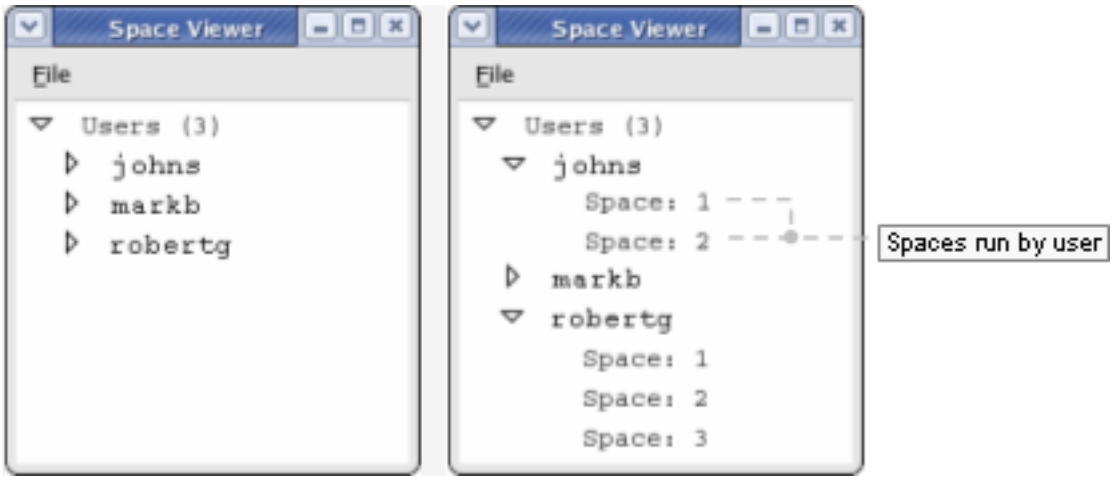
Space Viewer (located in bigworld/tools/server/space_viewer) logs and displays a dynamic graphic representation of the distribution of cells on a space, and the entities (player characters, NPCs, and other objects) on those cells.

Space Viewer uses a client/server architecture, and is therefore composed of two distinct parts, which may be used simultaneously or separately. The "server" side either communicates with the BigWorld server to collect and log information about a space, or reads a previously written log. The "client" side connects to the server process and displays the space information it provides.

Since the two halves of Space Viewer communicate via TCP, they can be run on different machines, although obviously the client is most responsive when both parts are run on the same machine.

The most common use of Space Viewer is generally to monitor the state of a live BigWorld server, and as such, both the client and server components are run in tandem. Other times, when space data needs to be collected over long periods of time (for example, during testing), the server part of Space Viewer (svlogger.py) will be run on its own, with the option to connect a client window to it at any time to examine the current state or look back through the log recorded thus far.

In the most common case of merely wanting to monitor an active server, and not being interested in extended period logging, Space Viewer will be started by simply running space_viewer.py. Its main window is displayed below:



Space Viewer window

3.4.2.1. Selecting Spaces to View

SpaceViewer displays a list of user IDs that are currently running BigWorld server clusters. If you do not see your UID listed in Space Viewer, then select **File → Refresh** menu item — this is necessary because the list is not automatically refreshed.

In the example above, users 502, 573 and 589 are running server clusters.

Clicking the icon to the left of user name expands the list to display all spaces available for that server instance.

In the example above, the server cluster run by user 502 has spaces 2, 5 and 9. To see the map of a space, double click its entry on the list. This will start an svlogger process logging data from the selected space, as well as a client window that is connected to it. Closing the client window will cause the logger to terminate and exit.

3.4.2.2. Menu Items

The list below describes the menu item available in the Space window:

- File → Close window and terminate Logger

  Closes the Space window and terminates the Logger. This item does not quit the Space Viewer.

- File → Close window

  Closes the Space window. This item does not quit the Space Viewer.

- View → Update entities

  Specifies that entities' position is determined by polling the currently selected cell.

  Note: It is possible to view entities from only one cell at a time.

- View → Set Cell App Update Frequency

  Opens the Change Display Update Interval dialog box, where you can change how often entity positions are queried from the cell.

  Smaller values for this settings cause greater load on the cell. In large systems, it is recommended to increase the delay (*e.g.*, to 3 seconds)

- View → Set Cell App Manager Update Frequency

  Opens the Change Display Update Interval dialog box, where you can change how often the cell boundaries are queried from the CellAppMgr and redrawn.

- View → Zoom in

  Displays a smaller area of the space.

- View → Zoom out

  Displays a bigger area of the space.

- View → Zoom to space bounds

  Automatically zooms to the extents of the current space.

- View → Image overlay → Display image overlay

  Opens the Choose An Image To Overlay dialog box, where you can choose the file with the image to superimpose onto the display.

  The image would typically be a screenshot from inside WorldEditor.

  Examples are provided in fantasydemo/res/server/space_images.

- View → Image overlay → Remove image overlay

  Disables the display of an image overlay.

- View → Image overlay → Recent image overlays

  List of most recent image overlays.

- View → Graph overlay → Display graph overlay

  Opens the Choose A Graph File dialog box, where you can choose the file with the graph topology to superimpose onto the display.

File should have the XML format accepted by the standard bots Patrol movement controller. For more details, see "Controlling Movement" on page 104 .

The user will be prompted to specify the factor by which the specified graph should be resized.

This feature is useful when you are running tests with bots.

Sample graph topologies can be found in fantasydemo/res/server/ bots.

- View → Graph overlay → Remove graph overlay

  Disables the display of a graph overlay.

- View → Graph overlay → Recent graph overlays

  List of most recent graph overlays.

- **Colour → CellApp ID**, **Colour → IP address**, **Colour → Cell load**, **Colour → Partition load**, **Colour → Entity bounds**, **Colour → Space boundary**, **Colour → Grid**, **Colour → Ghost entity**, **Colour → Cell boundary**

  Lets you select a colour to draw the specified element in.

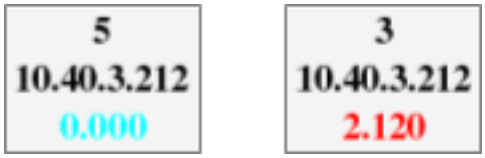
  A sub-menu displays the colours available for rendering the element.

  If you do not want the item to be displayed, then select `None`.

- Colour → Relative colouring

  Colours the CellApp load information according to its load.

  Colour will range from aqua blue (light loaded) to full red (heavy loaded).



Light-load CellApp and Heavy-load CellApp

- Entity size → 25%, Entity size → 50%, Entity size → 75%, Entity size → 100%, Entity size → 150%, Entity size → Custom scale...

  Sets the size of the entity symbol to the specified scale.

  If the Custom Scale menu item is selected, then a dialog will open, letting you specify a value ranging from 1 through 1,000.

- Util → Retire selected cell

  Item available mainly for debugging purposes.

  Removes the selected cell from the system.

  Note that CellAppMgr will probably add the cell back when it performs auto load balancing.

- Util → Stop selected CellApp

  Item available mainly for debugging purposes.

Stops the selected CellApp process.

- Visible entities → Show all

  This will set all entity types in the selected cell as visible, giving a complete view of all entities.

- Warp → Warp to time

  Opens the Warp dialog box, where you can specify the date and time for which you want to display space data.

- Warp → Warp to log event

  Opens the Choose A Timestamped Log dialog box, where you can specify the log file containing the space data that you want to display.

- Help → Help

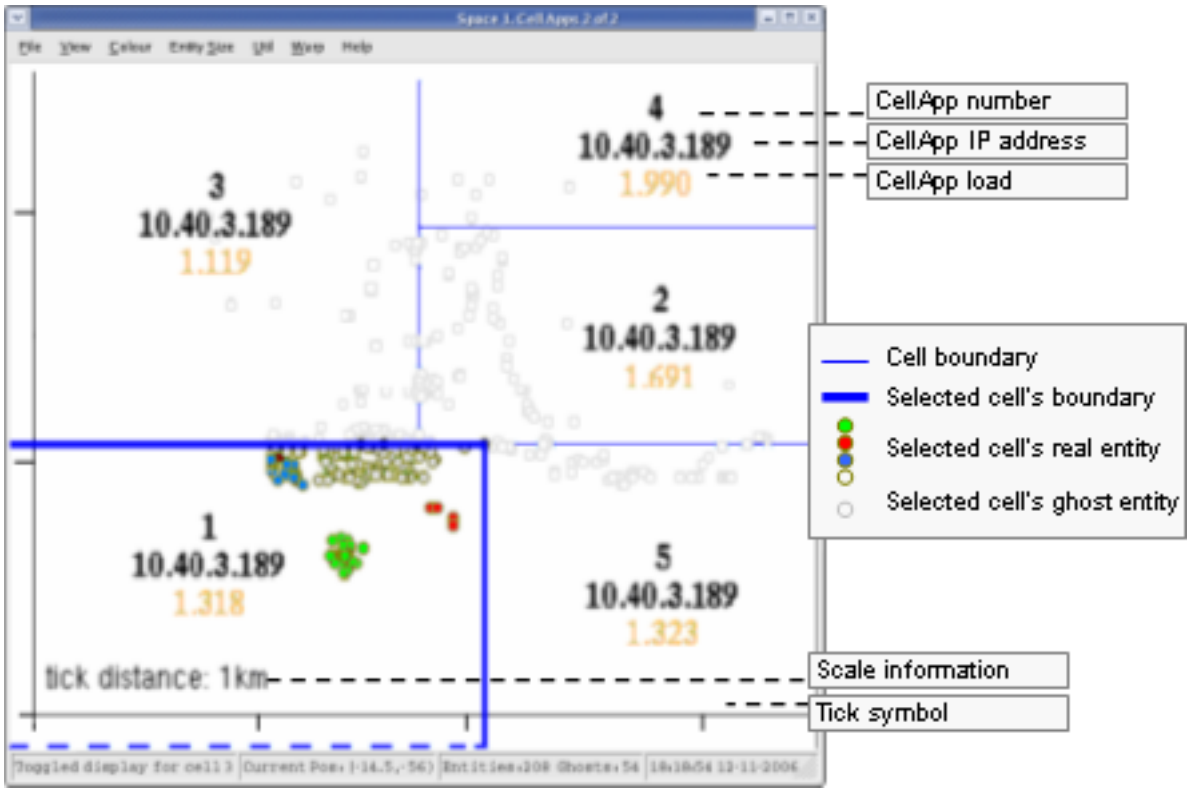
  Displays help for Space window.

3.4.2.3. Viewing Spaces

Multiple spaces can be viewed simultaneously, each in their own window. To view a space, double-click its entry on the space list displayed in Space Viewer.

The example below shows a space being handled by five cells. It is important to note that in the selected cell only the entity types selected in the **Visible Entities** menu item will be displayed. All ghost entities will be drawn regardless of the entities selected in this menu.

Initially, no cell on the space will be selected for viewing. The cell boundaries and the cell information (IP address, load, etc...) will always be shown, but to see the entities on a particular cell (as with cell #1 in the screenshot below) it must be selected with a single click



Space window

The list below describe some of the components of the Space window:

- **CellApp load**

  CPU load calculated by the CellApp itself.

- **Selected cell's real entity**

  The dots are coloured according to their type. For more details see “Customising Entity and Display Colours” on page 80 .

- **Scale information**

  Indicates the size of the viewed area (space and cells). In the example above, the space is slightly over 3km x 4km.

- **Cell boundary**

  If the displayed space contains more than one cell, then the geographic tessellation will be indicated.

- **Cursor position**

  Displays the current position of the cursor (x,z) in metres.

- **Entities information**

  Displays the number of real and ghost entities on selected cell.

To change the visualisation of the space via keyboard or mouse, you have the following options:

- **Select a cell**

  Click anywhere in a cell to make it active. Click on the cell again to deselect it.

- **Move the view**

  Click within the display and drag the mouse to move the cell display.

- **Zoom in/out**

  To zoom in and out of the display, use the Page Up and Page Down keys, or the mouse wheel.

  You can also use the middle mouse button to draw a rectangle, thus selecting the new area to view. As you zoom, scale information is updated to reflect the changes. If you get lost, restart the visualisation by selecting the **View✣Zoom To Space Bounds** menu item, or by pressing `Ctrl+Home`.

You can also seek the space view forwards or backwards in time using the keyboard. You can seek backwards as far as the time the logger was started, and if you seek forward to the current time, then the window will start updating in real time again.

The list below displays the keyboard shortcuts for controlling playback:

- **`LEFT ARROW`**

  Moves the playback 1 second backwards.

- **`RIGHT ARROW`**

  Moves the playback 1 second forward.

- **UP ARROW**

  Moves the playback 60 seconds backwards.

- **DOWN ARROW**

  Moves the playback 60 seconds forward.

- **Home**

  Moves the playback to the beginning of the log.

- **END**

  Moves the playback to the end of the log.

- **Ctrl+L**

  Prompts the user to select a command log file — this can be any file in which each line contains date/time string like '`Thu Nov 17 17:45:45 2005`'..

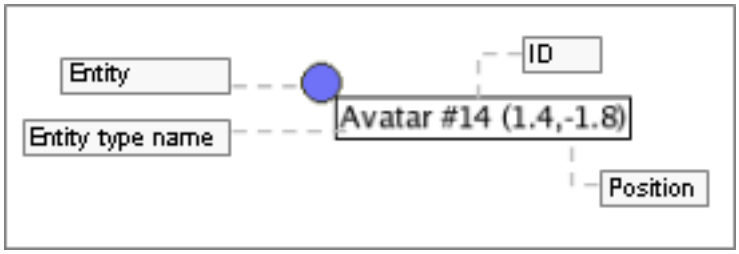
  Once the file is selected, the script will display all logged events contained in the log file, and prompt the user to select one.

  Once event is selected, playback time will be warped to the time of selected event.

- **Ctrl+W**

  Prompts the user to enter a time to warp the playback to.

In order to facilitate identification of entities there is also tool tip information for all non-ghosted entities. This information will appear if the cursor hovers over an entity marker for a sufficiently long time.



Entity tooltip

The entity type name is retrieved from file `<res>/scripts/entities.xml`, and corresponds to the IDs in the menu Visible Entities described above.

3.4.2.4. Customising Entity and Display Colours

Space Viewer allows you to customise the colours to be used when drawing the elements in the Space window. But this customisation is not saved, and will not be in effect the next time the application is started.

However, it is possible to permanently change the colours by customising a Python file.

Entities in the current cell are displayed with a coloured dot. The colour can be customised in the local file style.py. The simplest way is to update the dictionary colours (which contains RGB colour definitions for each entity type).

The code fragment below illustrates the definition of permanent entity colours:

```
# specify colour for entity Types.
```

```
entityColours = {
0: ((111, 114, 247), 2.0),
1: ((244, 111, 247), 1.0),
2: ((124, 247, 111), 1.0),
3: ((114, 241, 244), 1.0),
4: ((21,  168, 179), 1.0)
}
```

Example local file `style.py`

The entity's number is defined by its order of appearance in file `<res>/scripts/entity.xml`. Entities which ID is not defined in the dictionary are coloured with RGB (255,192,192).

So assuming the following file `<res>/scripts/entities.xml`, these will be the entities' display colours:

```
<root>
  <Knight/>
  <Warlock/>
  <Merchant/>
  <Guard/>
  <Ripper/>
  <Thief/>
  <Foreigner/>
</root>
```

Example file `<res>/scripts/entities.xml` and their display colours in Space Viewer

You can also replace the entire function getColourForEntity(entityID, entityTypeID), using your own algorithm to colour the entities.

All other colours are defined by the dictionary colourOptions. They can be changed to any of the colours defined by the colours array.

3.4.2.5. Running the Client and Server Parts of Space Viewer Separately

As described at the start of this section, Space Viewer's two halves can be run separately as needed. This would usually take the form of running svlogger over an extended period of time, connecting clients to it to monitor live state as necessary, then eventually shutting down the logger. Later, the logger can be connected to its previously recorded log (instead of a live server) and client windows can be attached to it to replay the log data.

3.4.2.5.1. `svlogger.py`

The svlogger script provides log writing and reading for Space Viewer. In writing mode, it is responsible for gathering the space data from the actual running BigWorld server (which it does by polling the CellAppMgr every second or so). In reading mode, it opens a previously recorded log for replay via any client connections.

The basic options for `svlogger` include:

- **`-l <listenip:listenport>`**

  Specifies the port that svlogger will listen for connections from svreplay. If not specified, any available port will be used.

- **`-o <logdir>`**

  Specifies the directory to write the data log to. Default is `/tmp/svlog`.

- **`-p <prefix>`**

  Specifies the prefix for the log files. Default is `svlog`.

- **`-s <spaceid>`**

  Specifies the space to log data for. Default is the server's default space.

- **`-u <uid>`**

  Specifies the user to log data for. Default is current user's ID.

- **`-k | --keepalive`**

  Specifies that the logger should terminate once the last client connection is terminated. Useful when only interested in monitoring a live server, and not interested in logs.

- **`-r <logpath>`**

  Activates replay mode for the log stored at the given path.

  The path is the concatenation of the `<logdir>` and `<prefix>` specified for `-o` and `-p` switches, respectively. For example, if you want to replay the default log location, you would specify `/tmp/svlog/svlog` as the `<logpath>`.

  This option can also be passed to `space_viewer.py` to open a log with `svlogger` and automatically connect a viewer window to it.

3.4.2.5.2. Connecting a Client Window to svlogger

If you have started `svlogger` manually, then you will also need to manually connect client windows to the logger if you wish to view its space data. This is easily done by running `space_viewer.py` with the `-c <ip:port>` option. The address passed to this option should be the address that svlogger is listening for connections on (which is displayed in the initial output from svlogger after it starts up).

3.4.2.6. Command-Line Options

Located under folder `bigworld/tools/server/space_viewer`, `space_viewer.py` can be called via command line with the following syntax:

```
space_viewer.py [{-u |--uid=}<user_id>]
                [{-s |--space=}<space_id>]
                [{-c |--connect=}<ip:port>]
                [{-r |--replay=}<log_prefix>]
                [{-d |--dump-db=}<log_db>]
                [--autoselect]
                [-h|--help]
```

The options for `space_viewer.py` are interpreted by Tcl/Tk's wish command, and are described in the list below:

- **`{-u |--uid=} <user_id>`**

  User for whose space is to be viewed. If this option is used, then `-s|--space` must also be specified.

- **`{-s |--space=} <space_id>`**

Space to view. If option `-u|--uid` is not specified, then the viewed `space_id` will be that of current user.

- **`{-c |--connect=} <ip:port>`**

  Address on which to connect to `svlogger.py`. For details, see "Connecting a Client Window to svlogger" on page 82 . If this option is specified, the `-u` option must not be specified.

- **`{-r |--replay=} <log_prefix>`**

  Opens log with `svlogger` and automatically connects a viewer window to it.

- **`{-d |--dump-db=} <log_db>`**

  Displays all values from `log_db`.

- **`--autoselect`**

  On startup, automatically selects a cell on specified space. If this option is used, then `-s|--space` must also be specified.

- **`-h|--help`**

  Displays online help.

Chapter 4. Watcher (Web Interface)

A Watcher is a general mechanism that exposes internal operational parameters of a running BigWorld Server, so that an administrator can view and change them.

Note

As of BigWorld 1.8, this tool is replaced by the new tool WebConsole. For details, see “WebConsole” on page 45 .

The Watcher web interface process collects watcher data and publishes it through an HTTP interface. It is mainly used to diagnose and rectify an isolated problem once it has been discovered. For details on how to instrument your own server processes and extensions, see Server Programming Guide, chapter The Watcher Interface.

Located on bigworld/tools/server, the watcher process listens for UDP broadcast messages from the server components containing announcements of new sources of watchers. It then publishes this information via an HTTP interface. When links are clicked on, the interface performs deeper watcher requests on behalf of the user.

To start a watcher process, execute the following command on any machine in the server cluster:

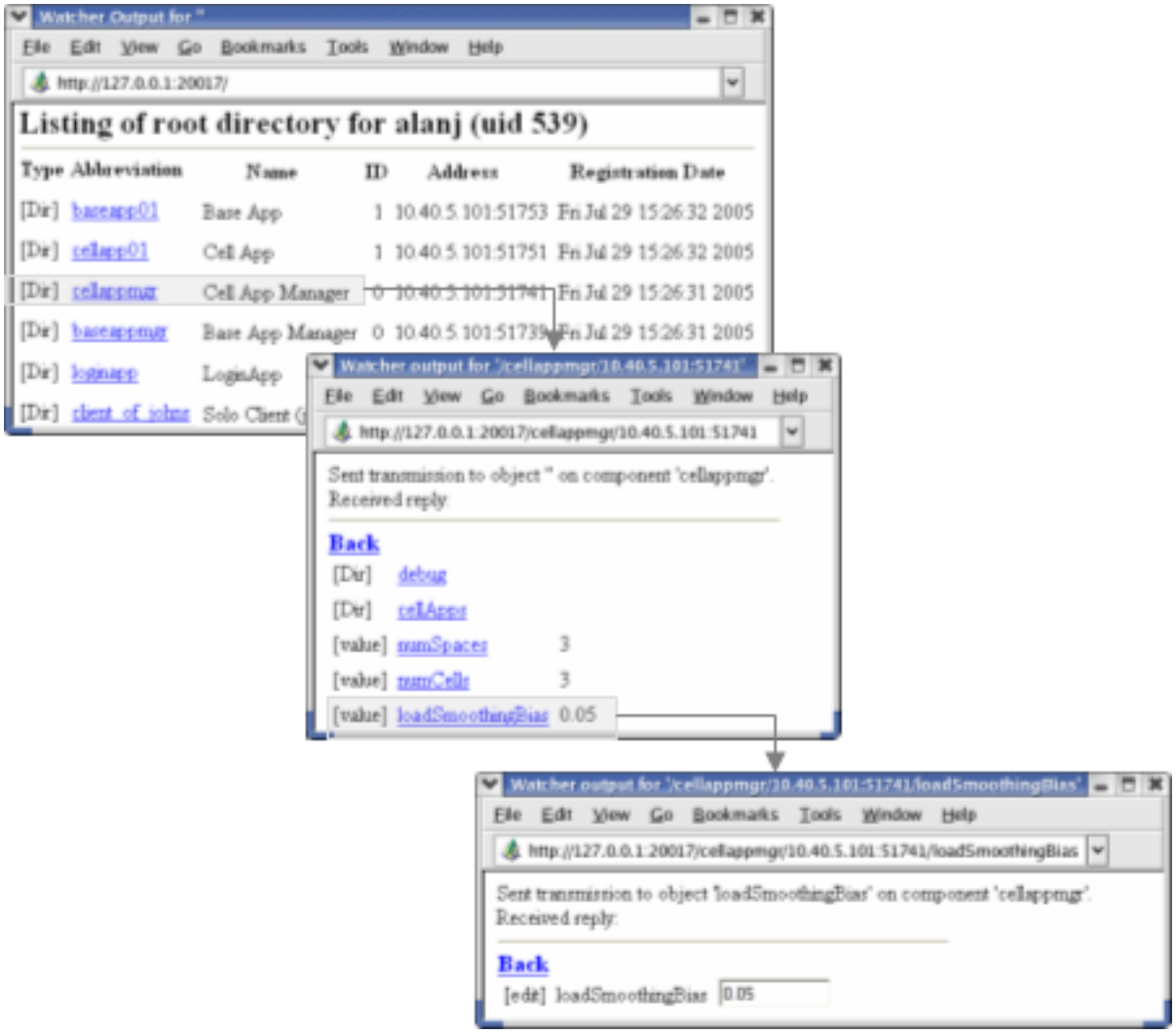
```
$MF_ROOT/bigworld/tools/server/watcher &
```

The watcher process listens for HTTP requests on port 20017. To view watcher information, just open a browser (on Windows or Linux) on address http://yourhostname:20017. The hyperlinks give you access to the watcher tree.

Note

Each watcher only shows the components registered under the UID that was used to start the watcher process — client machines are shown on all watchers, since they run on Windows boxes, and therefore do not have Unix UIDs.
You can run multiple watcher processes on the network.

The illustrations below display a watcher tree being traversed on a web browser:



Web page with CellAppMgr's `loadSmoothingBias` watcher

Chapter 5. Fault Tolerance

The Fault Tolerance system in BigWorld is designed to transparently cope with the loss of a machine due to physical, electrical, or logical fault.

The game systems in general should not be affected, and the game experience will continue normally for most clients, with possibly a brief interruption for clients closest to the faulty machine.

The loss of any single machine (running a single process) is always handled. The loss of multiple machines in a short time frame may not always be adequately handled. In such extreme cases — for example, a complete power outage affecting all machines — the Disaster Recovery system will be invoked. For more details, see "Disaster Recovery" on page 92 .

Note that, in spite of handling failures, the Fault Tolerance system should not be relied upon to cover up a software bug that causes a component to crash. All such bugs should be found and fixed in the source code. If the bug is believed to be in BigWorld Technology code (and not in a customer's extension), then contact BigWorld Support with details of the problem. For more details, see *First Aid After a Crash* on page 121 .

5.1. CellApp Fault Tolerance

CellApp fault tolerance works by backing up the cell entities to their base entities.

As long as a backup period is specified for the cell entities, the fault tolerance for the CellApp processes is automatic. An operator should ensure that there is enough spare capacity in available CellApps to take up the load of a lost process.

For details on how to specify the CellApp backup period, see "CellApp Configuration Options" on page 25 .

Note

Cell entities without a base entity are not backed up, and therefore will not be restored if their process is lost.

Note

Since cell entities back up to base entities, running CellApp and BaseApp processes on the same machine should be avoided. If the entire machine is lost, this level of fault tolerance will not work.

For more details on the implementation of CellApp fault tolerance on code level, see the document Server Programming Guide's chapter Fault Tolerance.

5.2. BaseApp Fault Tolerance

The BaseApp supports a choice of two schemes for fault tolerance:

- **Distributed BaseApp Backup**

  Each BaseApp backs up its entities on other (more than one) regular BaseApps.

- **Non-distributed BaseApp Backup**

  Regular BaseApps back up all their entities on dedicated Backup BaseApps.

Note

As of BigWorld 1.9, non-distributed BaseApp is deprecated. It is planned that support for this feature will be removed in BigWorld 2.0.

For more details, see the document Server Overview's section Server Components → BaseApp → Fault tolerance. For details on the implementation of BaseApp fault tolerance on code level, see the document Server Programming Guide's chapter Fault Tolerance.

The backup method is determined by `bw.xml`'s configuration option `baseAppMgr/useNewStyleBackup`. For details, see “BaseAppMgr Configuration Options” on page 22 .

Note

BigWorld recommends the Distributed BaseApp Backup method, for the following reasons:

- No need for dedicated Backup BaseApps.
- Backup load is distributed over a period of time.
- No need for IP switching, which might not be allowed by operating system and/or router. This also makes cluster management easier.

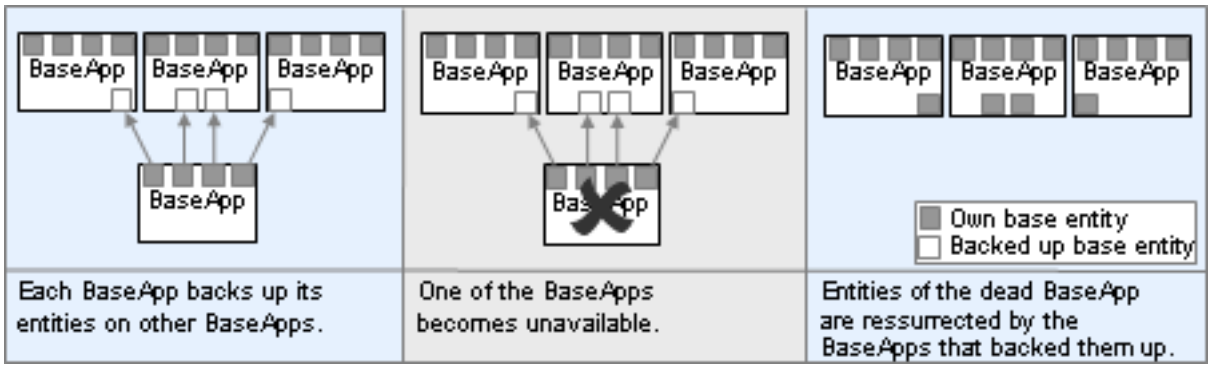
5.2.1. Distributed BaseApp Backup Method

This fault tolerance method does not require differentiating between normal and backup BaseApps — all BaseApps can perform both roles.

Each BaseApp is assigned a set of other BaseApps and a hash function from an entity's ID to one of these backups. Over a period of time, all entities are backed up. This is then repeated. If a BaseApp dies, then the entities are restored on to the appropriate backup.

Advantages of this method include that the backup can be done over a period of time, there is no need for dedicated backup BaseApps or IP switching.

Disadvantages include the possibility of base entities that were previously on the same BaseApp end up on different BaseApps (which places limits on scripting), and the fact that attached clients will be disconnected on BaseApp failure, requiring a re-login.



Distributed BaseApp Backup — Dead BaseApp's entities can be restored to Backup BaseApp

5.2.2. Non-Distributed BaseApp Backup Method

In this method, a BaseApp can be started as either a normal BaseApp (which services requests and contains bases), or as a Backup BaseApp. A Backup BaseApp stores bases and entities backed up by one or more normal BaseApps, and takes over if one of them stops replying to watchdog pings.

The fact that Backup BaseApp can back up more than one BaseApp allows you to trade risk against hardware cost when deciding how many Backup BaseApps to install.

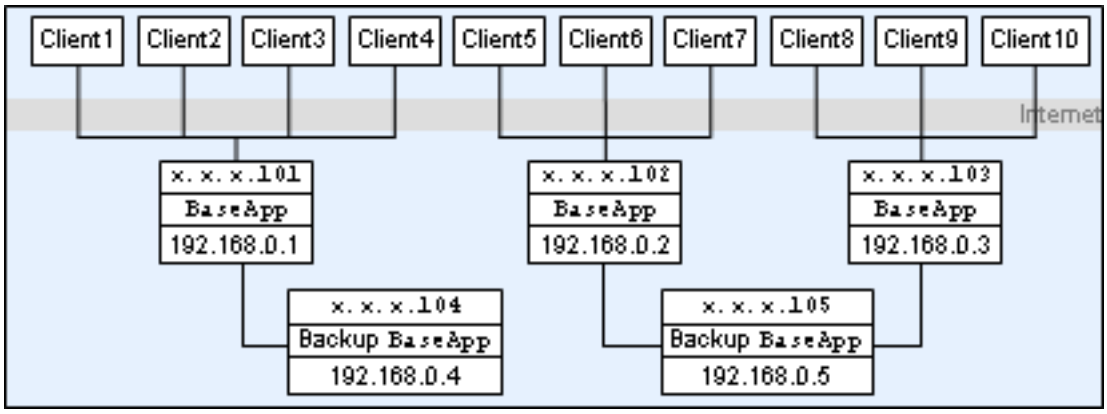
To start a BaseApp as a Backup, use the command below:

```
baseapp -backup
```

If a BaseApp does not have a corresponding Backup BaseApp, then it will search for one on the network. This is done as illustrated in the series of steps below:

1. **Initial state**

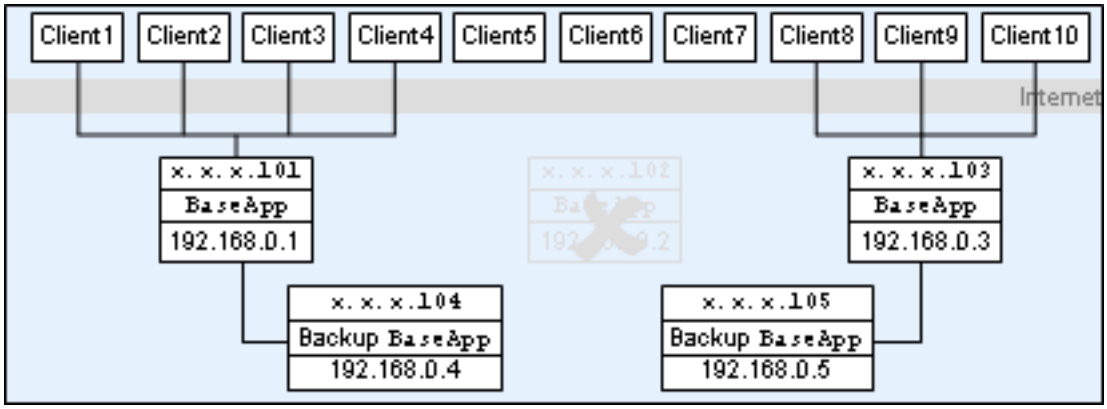
   This example supposes a class C network x.x.x.0 as the connection to the Internet, and a private network of 192.168.0.0, as illustrated below:



Initial state

2. **BaseApp becomes unavailable**

   If BaseApp x.x.x.102 becomes unavailable, then all base mailboxes for bases on it will still refer to the address 192.168.0.2, and Client5, Client6 and Client7 will have no proxy to communicate with, as illustrated below:



BaseApp becomes unavailable

3. **Backup BaseApp replaces unavailable BaseApp**

   Once the Backup BaseApp x.x.x.105 detects that it needs to replace the unavailable BaseApp, the following steps will take place.

   a. Backup BaseApp x.x.x.105 changes its internal and external IP addresses to the old BaseApp's ones.

   b. From this point one, Backup BaseApp on x.x.x.105 becomes know on the network as BaseApp x.x.x.102.

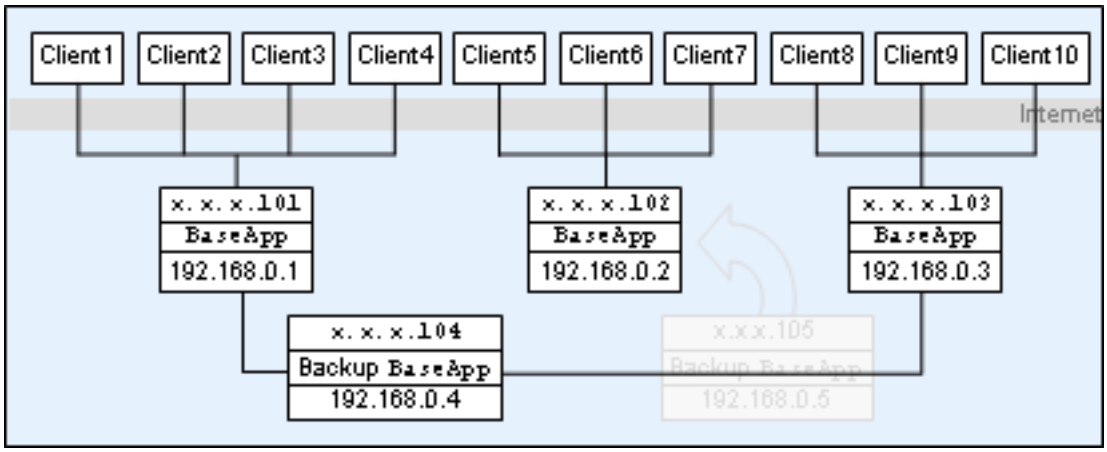
c. If the old machine is still responding, then new BaseApp x.x.x.102 issues a request to change its addresses.

d. New BaseApp x.x.x.102 creates all entities stored from the original one, calling onRestore for each one.

e. BaseApp x.x.x.103 and the new BaseApp x.x.x.102 can find a new Backup BaseApp.

f. Any process communicating with the old BaseApp x.x.x.102 can keep doing so with the new one, without any impact.

The final network configuration is illustrated below:



Backup BaseApp replaces unavailable BaseApp

5.2.3. IP Address Change

Since all network configurations have their own peculiarities, the process of changing IP addresses is delegated to a shell script. However, the BaseApp first executes a program called `change_ip`, since changing IP addresses is typically restricted to the root user, and Linux does not allow shell scripts to be launched with suid root. This program calls `setuid(0)`, and then executes the script `../scripts/change_ip.sh` relative to its working directory.

Because of this, you should ensure that appropriate permissions are set for each of these two files. The permissions can be set with the commands below:

```
chown root bigworld/bin/scripts/change_ip.sh
chmod 700  bigworld/bin/scripts/change_ip.sh
chown root bigworld/bin/Hybrid/change_ip
chmod +s   bigworld/bin/Hybrid/change_ip
```

The source code is located in folder `src/server/tools/change_ip/main.c`, and is compiled into `$MF_ROOT/bigworld/bin/$MF_CONFIG/change_ip`.

The script `change_ip.sh` is expected to be customised for each particular installation. The script is called with two command line parameters: the first is the interface to change the IP address for, and the second is the new IP address for the machine.

5.2.4. Further Considerations

Things to consider while configuring BaseApp fault tolerance include:

- Do your routers place any special requirements on the IP changeover, such as forcing ARP broadcasts, or changing MAC addresses as well?

- Do you need to have a separate monitoring network?

  Both the internal and external BaseApp IP addresses are subject to change, and so it can be useful to have a fixed IP address on the system, for administrative purposes. This may just be an alias on the internal interface (established with the command call `ipconfig eth1:0 192.168.0.1`, for example.) This could be very useful, for example, to ssh a machine with problems.

Due to a number of issues that can arise from changing the IP address of the machine, BigWorld has an option to only pair backup BaseApps with BaseApps on the same machine, which removes the need to change IP address of a machine. This is set by `bw.xml`'s `baseAppMgr/onlyUseBackupOnSameMachine` configuration option (for details, see "BaseAppMgr Configuration Options" on page 22 .).

5.3. Fault Tolerance with Reviver

Fault tolerance for BaseAppMgr, CellAppMgr, DBMgr, and LoginApp is provided by the Reviver, by starting a new instance of the process to replace the unavailable one.

Although it is possible for one Reviver to watch all processes, it is recommended to run a few of them on different machines, since Revivers normally stop after reviving a process.

For more details on Reviver, see the document Server Overview's chapters Design Introduction and Server Components.

5.3.1. Specifying Components to Support

The file `/etc/bwmachined.conf` can contain entries for categories, and a list of items pertaining to it, with the syntax below (the asterisk character — `*` — meaning 0 or more occurrences):

```
*[<category>]
*<item>
```

Please note that this setting can only be specified on the global configuration file.

Tools can query BWMachined to find the tags associated with categories. Categories may be used by future tools or customer-created tools.

An example `/etc/bwmachined.conf` would have its bottom part as below (since the top part will contain user settings, as described in the section above):

```
[Colours]
blue
green
red
```

When the Reviver starts, it queries the local BWMachined process, and will only support the components that have an entry in a special `<category>` called `Components` on `/etc/bwmachined.conf`.

An example `/etc/bwmachined.conf` specifying that the Reviver should support all singleton server components would have its bottom part as below:

```
[Components]
baseApp
baseAppMgr
cellApp
cellAppMgr
dbMgr
```

```
loginApp
```

Note

If the `[Components]` category does not contain any entries, then Reviver will support all singleton server components.
BaseApp and CellApp will not be restarted by Reviver — the `[Components]` entries are used by WebConsole and `control_cluster.py` to determine which processes should be started by BWMachined on that host.

The configuration file is only read when BWMachined starts. It will have to be restarted if you want it to acknowledge your changes.

5.3.2. Command-Line Options

The supported components can also be specified via command-line (even though we recommend that you use `/etc/bwmachined.conf` for that), as below:

```
reviver [--add|--del {baseAppMgr|cellAppMgr|dbMgr|loginApp} ]
```

If reviver is invoked with no options, then it will try to monitor all singleton processes specified in category `Components` of `/etc/bwmachined.conf`.

The options for invoking reviver are described in the list below:

- **`--add { baseAppMgr | cellAppMgr | dbMgr | loginApp }`**

  Starts the Reviver, trying to monitor only the components specified in this option. That means that the components list in `/etc/bwmachined.conf` will be ignored.

- **`--del { baseAppMgr | cellAppMgr | dbMgr | loginApp }`**

  Starts the Reviver, trying to monitor all components specified in the list in `/etc/bwmachined.conf`, except the ones specified in this option.

- **To start Reviver trying to monitor all processes specified in Components in /etc/bwmachined.conf:**

  ```
  reviver
  ```

- **To start Reviver trying to monitor only DBMgr and LoginApp:**

  ```
  reviver --add dbMgr --add loginApp
  ```

- **To start Reviver trying to monitor all processes specified in Components in /etc/bwmachined.conf, except DBMgr and LoginApp:**

  ```
  reviver -del dbMgr -del loginApp
  ```

Chapter 6. Backups and Disaster Recovery

BigWorld's fault tolerance ensures that the server continues to operate if a single process is lost. The server also provides a second level of fault tolerance known as disaster recovery that comes into play when multiple server components fail at once and the server needs to be shut down.

For additional protection against exploits or bugs the database should be backed up regularly. The snapshot tool facilitates making backups of the database.

6.1. Disaster Recovery

The server's state can be written periodically to the database. In case the entire server fails, then it can be restarted using this information. To enable the periodic archiving of entities, an archive period needs to be set via the configuration option `archivePeriod` for BaseApp and CellAppMgr processes. For more details, see “BaseApp Configuration Options” on page 15 , and “CellAppMgr Configuration Options” on page 32 .

Disaster recovery only works when the underlying database is MySQL — it does not work when the XML version is used. Please see *DBMgr MySQL Support* on page 114 for more information about about enabling MySQL support in BigWorld.

Starting the server using recovery information from the database is the same as starting it from a controlled shutdown. For more details, see *Controlled Startup and Shutdown* on page 97 .

For details on the scripting API related to disaster recovery, see the document Server Programming Guide's chapter Disaster Recovery.

6.2. Database Snapshot Tool

For background information on the need for the snapshot tool see Server Programming Guide's chapter Database Snapshot.

The snapshot tool is a Python script that facilitates making a backup copy of the database that combines information from the primary database and secondary databases. It is located in `bigworld/tools/server/snapshot/snapshot.py`. In its current form, it should be considered as example code. It should be reviewed and customised for each environment.

The snapshot tool should be run on a separate machine to avoid interfering with the normal operation of the server. The snapshot tool can use a significant amount of CPU and disk resources and does so in a fairly spiky manner. We will refer to the machine running the snapshot tool as the snapshot machine.

The snapshot tool performs the following sequence of operations:

1. Runs the **transfer_db** command on each BaseApp. **transfer_db** performs a snapshot of the secondary database and sends the snapshot to the snapshot machine using the **rsync** command.
2. Runs the **transfer_db** command on the primary database's MySQL server. **transfer_db** performs an LVM snapshot of the primary database and sends the LVM snapshot to the snapshot machine using the **rsync** command.
3. Starts a MySQL server on the snapshot machine and specifies its data directory to be the copy of the primary database.
4. Runs the data consolidation tool on copies of the primary and secondary databases.
5. Archives the consolidated snapshot.

The snapshot tool logs all messages to **message_logger**. A snapshot should be considered invalid if there is an error.

The snapshot tool accepts a single command-line argument and command line options. The snapshot tools help message is below:

```
Usage: snapshot.py [options] SNAPSHOT_DIR

Options:
  -h, --help            show this help message and exit
  -b BWLIMIT_KBPS, --bwlimit-kbps=BWLIMIT_KBPS
                        file transfer bandwidth limit in kbps, default is
 unlimited
  -n, --no-consolidate  skip consolidation, default is false
```

The list below provides some common examples of using the snapshot tool:

- **snapshot.py /home/bwtools/snapshots**

  Takes a snapshot. The snapshot is archived to`/home/bwtools/snapshots`.

- **snapshot.py /home/bwtools/snapshots --bwlimit-kbps=5000**

  Takes a snapshot. The snapshot is archived to`/home/bwtools/snapshots`. Each secondary and primary database is transferred with a 5000 kbps bandwidth limit.

- **snapshot.py /home/bwtools/snapshots --no-consolidate**

  Takes a snapshot. The unconsolidated snapshot is archived to`/home/bwtools/snapshots`.

- **snapshot.py /home/bwtools/snapshots -n -b5000**

  Takes a snapshot. The unconsolidated snapshot is archived to`/home/bwtools/snapshots`. Each secondary and primary database is transferred with a 5000 kbps bandwidth limit.

6.2.1. Configuration

For the snapshot tool to work, the following conditions must be met:

- **bwmachined** must be running on the primary database machine. For background information see Server Overview's chapter Server Components→BWMachined.
- All the entity scripts and entity definition files must be present on the snapshot server. `.bwmachined.conf` must be configured correctly for the user running the snapshot tool.
- The snapshot section in `/etc/bigworld.conf` must be configured correctly on the primary database machine.
- The primary database is stored in an LVM volume and there is sufficient unpartitioned space on the primary database machine to perform an LVM snapshot.
- The directory the LVM volume is to be mounted to exists and has no other devices mounted to it.
- The snapshot user must be able to connect to the snapshot machine using **ssh** from the primary database machine and BaseApp machines without a password. For a user whose **$HOME** directory is on a NFS, this can be done via the command-line as below:

```
$ ssh-keygen -t dsa
$ cat ~/.ssh/id_dsa.pub >> ~/.ssh/authorized_keys
```

- **lvcreate**, **lvremove**, **mount**, **unmount** and **chmod** must be installed and on the path of the primary database machine.
- **mysqld_multi** must be installed and on the path of the snapshot machine.
- **rsync** must be installed and be on the path of the snapshot, the primary database and all the BaseApp machines.
- The **snapshot_helper** utility must be built. To build **snapshot_helper**, MySQL development files must be installed. Please see "Compiling DBMgr with MySQL Support"on page 114 for details on how to install MySQL development files. After installing MySQL development files, issue the **make** command from within the `bigworld/src/server/tools/snapshot_helper` directory.
- **snapshot_helper** has its setuid attribute set so user ID is root upon execution on the primary database machine. This can be done via the command-line as below:

```
# chown root:root $MF_ROOT/bigworld/tools/server/snapshot/snapshot_helper
# chmod 4511 $MF_ROOT/bigworld/tools/server/snapshot/snapshot_helper
```

For security, all privileged commands (**lvcreate**, **lvremove**, **mount**, **unmount** and **chmod**) are invoked via **snapshot_helper** which reads command arguments from the trusted `/etc/bigworld.conf.`

The keywords in the `/etc/bigworld.conf` are described in the list below:

- **`datadir`**

  The primary database MySQL server's data directory.

- **`lvgroup`**

  The name of the LVM volume group in which the primary database belongs to. The LVM snapshot volume will also belong to this group.

- **`lvorigin`**

  The name of the origin LVM volume snapshotted. The MySQL data directory should be on this volume.

- **`lvsnapshot`**

  The name of the LVM snapshot volume that will be created and deleted by the snapshot tool. This name is also use to generate the snapshot volume mount path, `/mnt/lvsnapshot`, which must already exists.

- **`lvsizegb`**

  The size of the LVM snapshot volume in gigabytes. The snapshot does not need the same amount of storage the origin has as only the modified files are copied, in a typical scenario, 15-20% might be enough. If the LVM snapshot volume becomes full it will be dropped ,so it is important to allocate enough space.

Below is an example `/etc/bigworld.conf` configuration file:

```
[snapshot]
datadir = /var/lib/mysql
lvgroup = VolGroup00
lvorigin = LogVol00
lvsnapshot = bwsnapshot
lvsizegb = 2
```

Note: The snapshot tool also reads `<res>/server/bw.xml` for the `dbMgr/host`, `dbMgr/username`, `dbMgr/password` and `dbMgr/databaseName.`

6.3. Data Consolidation Tool

The data consolidation tool is used to incorporate data from secondary databases into the primary database. It is called **consolidate_dbs** and is located in `bigworld/bin/Hybrid/commands`. This tool is only provided in source code form and must be built before use. Please see "Enabling Secondary Databases" on page 115 for details on how to build the data consolidation tool.

Once this tool is built, it will be automatically run during system shutdown or during system start-up if the system was not shutdown correctly. There should be no need to manually run this tool except for consolidating backups created by the snapshot tool (see "Database Snapshot Tool" on page 92). This tool logs messages to Message Logger which can be viewed using the Log Viewer tool in Web Console.

This tool will accept two command-line arguments:

- **Primary Database**

  The parameters required to connect to the primary database should be specified in the form *`host;username;password;database_name`*. When specifying this on the command-line, it is necessary to quote the entire parameter to prevent the shell from treating it as multiple commands.

- **Secondary Databases**

  A file containing a newline separated list of fully qualified paths to secondary database files.

When run without command line arguments, it will use DBMgr's configuration options located in `<res>/server/bw.xml` to connect to the primary database. It will use the data in the `bigworldSecondaryDatabase` table to retrieve the secondary databases.

The data consolidation tool uses the **transfer_db** utility located in located in `bigworld/bin/Hybrid/command` to transfer the secondary database files from the BaseApp machines to the machine where the data consolidation tool is running. The **transfer_db** utility will be launched (via **bwmachined**) on each machine that contains a secondary database file. The **transfer_db** utility then opens a TCP connection to the data consolidation tool through which it will send the secondary database file.

The data consolidation tool will store the secondary databases locally in the directory specified by the `<dbMgr>/<consolidation>/<directory>` configuration option. It will incorporate the data from the secondary databases into the primary database once all the secondary database files have been transfered to its local machine. If the data consolidation process is sucessful, both the local and remote copies of the secondary databases will be deleted, and the `bigworldSecondaryDatabase` table will be cleared. If the data consolidation process is unsuccessful, only the local copy of secondary database files are deleted.

The data consolidation tool logs to Message Logger under the `ConsolidateDBs` process. Under most circumstances, the data consolidation tool will log errors from **transfer_db** as well. However, under some circumstances, **transfer_db** errors will appear under the `Tools` process. The **bwmachined** logs, in `/var/log/messages` on each machine where secondary databases are located, can help to diagnose problems, especially those related to the failure to run **transfer_db**.

6.3.1. Skipping Data Consolidation

If, for some reason, there is a problem with the data consolidation tool and the server refuses to start, the `bigworldSecondaryDatabase` table can be manually cleared to skip the data consolidation process. Alternatively, **consolidate_dbs** can be run with the command-line parameter `--clear` to achieve the same result.

While skipping the data consolidation process may allow the server to start again, the data in the secondary databases that were not consolidated is essentially lost. Though the secondary database files still exists, it is not recommended to try to consolidate the data after the server is restarted since the data in the primary database may be more recent than the data in the left over secondary databases.

6.3.2. Ignoring SQLite Errors

When **consolidate_dbs** encounters an error in reading a secondary database file, it will abort the entire data consolidation process. Such errors should be investigated and, hopefully, corrected. However, if a secondary database file is genuinely corrupted and cannot be repaired, then it may be preferable for **consolidate_dbs** to read as much data from the corrupted secondary database and then proceed to consolidate the rest of the secondary databases. When the `--ignore-sqlite-errors` command-line option is specified, **consolidate_dbs** will proceed to consolidating the next secondary database when it encounters an error instead of aborting the consolidation process.

Chapter 7. Controlled Startup and Shutdown

There are times when the server might need to be shut down, and restarted later in a similar state.

To tell the server to shut down in a controlled way, a message must be sent to all LoginApps. This may be in the form of a Watcher message or a USR1 signal. The easiest way to do this is to use the script `control_cluster.py` with the option stop or via WebConsole. For more details, see "`control_cluster.py`" on page 67 .

Controlled startup and shutdown only work when the underlying database is MySQL — it does not work when the XML version is used.

If the `bw.xml`'s `dbMgr/clearRecoveryData` configuration option is set to `false`, then the server is automatically started using information written during the controlled shutdown. If the server had failed unexpectedly, then it is started using the disaster recovery information. Setting that configuration option to `true` will cause the server to be started in its initial state, *i.e.*, an empty space with no entities. For more details, see "DBMgr Configuration Options" on page 35 .

The main information that is restored from the database is:

- Spaces and their data
- Game time
- Which entities should be in each space.

When using MySQL as the underlying database, this information is stored in the following tables:

- Spaces and their data — `bigworldSpaces`, `bigworldSpaceData`
- Game time — `bigworldGameTime`
- Which entities should be in each space — `bigworldLogOns`

For details on these tables, see the document Server Programming Guide's section MySQL Database Schema → Non-entity tables

For details on related scripting, see the document Server Programming Guide's chapter Controlled Startup and Shutdown.

Chapter 8. Stress Testing with Bots

The Bots application is a process that can command arbitrary numbers of simulated clients to log into the server and perform activities. It is written in C++, but controlled through Python, like the BigWorld Client.

8.1. The Login Process

The bots are designed to log in a server just like a real client. By default, the Bots process locates a LoginApp by broadcasting a message requesting all LoginApps to respond, and then using the first one to reply. This is the simplest method to log in if there is only one instance of a BigWorld server running.

The script is located in folder `bigworld/bin/$MF_CONFIG`, and has the following syntax:

```
bots [-serverName <srv> [-port <port>]]
     [-username <user> [-password <pwd>] [-randomName]] [-scripts]
```

The options for invoking bots are described in the list below:

- **`-serverName <srv>`**

  Server that the bot clients will login to (overrides the auto-locate method).

- **`-port <port>`**

  Login port. Ignored if Bots is using auto-locate method.

- **`-username <user>`**

  Username that the bot clients will log in as.

- **`-password <pwd>`**

  Password for bot clients' login.

- **`-randomName`**

  Randomises the login name based on the specified <username>.

- **`-scripts`**

  Enables Bots to run scripts. This has a considerable performance cost.

The auto-locate procedure can be overridden by specifying the option `-serverName <serverName>` on the command line. If both methods fail, then the Bots process requests the server name on stdin (if attached to a terminal). If all these methods fail, then the process starts, but cannot create new bots until the server is set (via the Python method `setDefaultServer`).

If the option `-scripts` is specified then Bots looks for the entity definition files under folder `<res>/scripts/entity_defs`, and for scripts under folder `<res>/scripts/bot`.

Specific scripts can be created for Bots, but if a client script does not reference the client's C++ modules, then it can be reused. Note that the bots process does not support the BigWorld Client APIs, since it is intended to be lightweight.

In many operation scenarios the entity definition file for Bots could be either missing or different from the definition files for the server. The Bots would use an incorrect message digest for login; and hence the login will fail because LoginApp relies on the digest for verifying entity definition consistency. Previously, only

way around this problem is turn the digest checking on the server off in `<res>/server/bw.xml`'s `dbMgr` options section (for details check `allowEmptyDigest` option in “DBMgr Configuration Options” on page 35 . This option can also be changed on the fly via a watcher, using WebConsole's ClusterControl module; see “ClusterControl” on page 45). However, this is not a viable option, if you want to use Bots on production servers. You can now set custom MD5 digest in the `<res>/server/bw.xml`'s `bots` section under option loginMD5Digest. This option can also be modified on the fly through WebConsole.

Bots can now realistically simulate general Internet networking environment by introduce artificial packet loss, network delays, sudden disconnections and frequent relogins. All this simulation can be programmed with Bots' personality script.

8.2. Watcher Interface

It is possible to control Bots using WebConsole's **ClusterControl** module (for details, see “WebConsole” on page 45).

The list below describes the watchers exposed by Bots:

- **`command/addBots`** (Data type — `int`, Access — Write only)

  Adds to the system the specified number of bots.

- **`command/delBots`** (Data type — `int`, Access — Write only)

  Deletes from the system the specified number of bots.

- **`command/updateMovement`** (Data type — `string`, Access — Write only)

  Updates the movement controllers of all bots matching the input tag, based on the current default values. If the input tag is empty, all bots are changed.

- **`defaultControllerData`** (Data type — `string`, Access — Read/Write)

  The argument string that default movement controllers are to be constructed with.

- **`defaultControllerType`**

  The name of the movement controller for the bots, if that is not specified individually.

- **defaultStandinEntity**

  Default entity script to be used when a specific Entity type does not have its corresponding game script.

- **loginMD5Digest**

  32 character long MD5 digest string (in hex readable form) for server login.

- **`delTaggedEntities`** (Data type — `string`, Access — Write only)

  Deletes all bots matching the input tag.

- **`numBots`** (Data type — `int`, Access — Read only)

  Number of bots being controlled by this process.

- **`pythonServerPort`** (Data type — `int`, Access — Read only)

  The telnet port the process is listening on (if it was available when the application started).

- **`tag`** (Data type — `string`, Access — Read/Write)

The current tag.

Note the unusual use of write-only fields to perform actions. The Watcher interface is rarely used, since bots are easier to control with the script bigworld/tools/server/ bot_op.py, or the Python interface.

For more details on changing a watcher via WebConsole, see “ClusterControl” on page 45 .

8.3. Python Interface

Bots was designed to be controlled programmatically via Python, but since Python can be used interactively, it is also a quick way to get some bots into the system and control them.

You can telnet to port 6075 to talk to the bots process, as illustrated below:

```
$ telnet 10.40.7.12 6075
Welcome to the Bot process
>>> BigWorld.getDefaultServer()
10.40.7.1
>>> BigWorld.setDefaultServer('server2')
>>> BigWorld.setDefaultTag('red')
>>> BigWorld.addBotsSlowly(500, 0.1)
>>> BigWorld.setDefaultTag('blue')
>>> BigWorld.addBotsSlowly(500, 0.1)
>>> BigWorld.addBotsWithName( [('Bot_01', '01'), ('Bot_02', '02')] )
```

Example of use of Python interface to Bots

8.3.1. Python Controller (bot_op.py)

BigWorld provides a Python program to simplify the management of large numbers of bots.

It automatically starts bot processes as needed, load balancing (based on CPU load) on all available machines not running any other BigWorld components.

The script is located in folder bigworld/tools/server and has the following syntax:

```
python bot_op.py [add [<number_of_bots>]]
                 [del [<number_of_bots>]]
                 [movement <controller_type> <controller_data> [<bot_tag>]]
                 [set (<watcher_name> <value>)+]
                 [run [<command>]]
                 [addprocs [<num_of_procs>]]
                 -u [username or uid]
```

The options for invoking `bot_op.py` are described in the list below:

- **`add [<number_of_bots>]`**

  Adds the specified number of bots to the system. If <number_of_bots> is not specified, then one bots is added.

  Bots are added 16 at a time, up to a maximum of 256 per bots process.

  The script waits 1 second after each add, to check it a bot was effectively added. When all bots processes are full, it creates a new process on an available machine that is using less than 80% CPU (preferably one that is already running some bots processes).

- **`addprocs [<num_of_procs>]`**

  Spawns the given number of bots processes on each machine that is considered eligible for running them, or 1 on each if no number is given.

- **`del [<number_of_bots>]`**

  Deletes the specified number of bots from the system. If <number_of_bots> is not specified, then it defaults to 1. The number of bots will be ceiling clamped to the actual number of bots on the server.

- **`movement <controller_type> <controller_data> [<bot_tag>]`**

  Changes the bot's movement controller. If option <bot_tag> is specified, then only bots matching it will be changed. Otherwise, all bots will be changed.

- **`set (<watcher_name> <value>)+`**

  Sets the watcher to specified value on all bot applications.

- **`run [<command>]`**

  Runs the specified Python command on all bots. If <command> is not specified, then it is read from stdin.

- **`-u [username|uid]`**

  Manually specify the UID of the server that the script will take action on.

8.3.2. Methods and Attributes

The list below describes the bots' attributes and methods on ClientApp and BigWorld:

- **ClientApp Attributes**
  - **`id (int)`** — Bot ID (read-only).
  - **spaceID(int)** — ID of the space the bot is currently in. 0 means not in any space (read-only).
  - **loginName(string)** — Bot's login name.
  - **loginPassword(string)** — Bot's login password.
  - **`tag (string)`** — Bot's user-specified tag. Allows the control of partial sets of bots.
  - **`speed (float)`** — Bot's speed.
  - **`position (Vector3)`** — Bot's position.
  - **`yaw (float)`** — Bot's yaw.
  - **`pitch (float)`** — Bot's pitch.
  - **`roll (float)`** — Bot's roll.
  - **isOnline(bool)** — Indicates whether the bot is connected to a server (read-only).
  - **isDestroyed(bool)** — Indicates whether the bot has been destroyed (read-only).
  - **entities(PyObject)**

    Dictionary-like attribute containing the list of entities that are in the simulated client's current AOI.

- **ClientApp Methods**
  - **logOn()**

    Initiate log on process for the simulated client to connect to a BW server.
  - **logOff()**

    Make a simulate client disconnect from server gracefully. If the simulated client is not online, it will do nothing.
  - **dropConnection()**

    Make a simulate client drop the connection with the server. If the simulated client is not online, it will do nothing.
  - **setConnectionLossRatio(float lossRatio)**

    Set up network packet loss ratio for simulating unstable network environment. Range between 0.0 and 1.0. 0.0 means no packet loss. 1.0 mean 100 percent packet loss.
  - **setConnectionLatency(float minLatency, float maxLatency)**

    Set up simulated network data latency (in milliseconds).
  - **moveTo(Math.Vector3 position)**

    Set next destination position for the player avatar of the simulated client.
  - **snapTo(Math.Vector3 position)**

    Set the player avatar position for the simulated client.
  - **stop()**

    Stop the player avatar of the simulated client moving.
  - **faceTowards(Math.Vector3 direction)**

    Set the direction of avatar of the simulated client.
  - **addTimer()**

    Add a timer for the bot client. This function returns an integer timer id; otherwise it returns -1.
  - **delTimer(int timerID)**

    deletes an active timer corresponding the timerID.
  - **onTick()**

    This optional function is invoked every game tick, should it be defined in the player Avatar script.
- **BigWorld Attrbutes**
  - **`bots`**

    Dictionary-like attribute containing the list of simulated clients. The key is the player's ID, and value is an instance of ClientApp.
  - **`bots [<player_id>]. entities`**

Dictionary-like attribute containing the list of entities created under the simulated client specified by `<player_id>`. The key is the entity's ID, and the value is the reference to the entity.

In non-script bots, only the player entity is created and stored in this attribute.

- **`bots [<player_id>].entities[<ent_id>].clientApp`**

  Attribute referring to the ClientApp that owns the entity. An entity can access its owner ClientApp via this attribute. `BigWorld.bots[<player_id>].entities[<ent_id>].clientApp` equals to `BigWorld.bots[<player_id>]`.

- **BigWorld Methods**

  - **setMovementController(string type, string data)** — Context: ClientApp

    Sets a new movement controller for the bot. On failure, the controller is left unchanged. Returns `true` on success, `false` on failure.

  - **setLoginMD5Digest(string MD5Digest)** — Context: BigWorld

    Set the 32 character long MD5Digest (in hex readable form) for server login. If the input string length is not exactly 32 character, the MD5 digest will be reset to empty.

  - **addBots(int numBots)** — Context: BigWorld

    Immediately adds the specified number of simulated clients to the application. If too many bots are added at once, then some of them may time out, depending on how long it takes to log in all of them.

  - **addBotsSlowly(int numBots,float delayBetweenAdd,int groupSize=1)** — Context: BigWorld

    Adds bots to the system in groups of groupSize, and add a delay between each group. This method returns immediately, adding the bots in the background, and is the best way to add bots to a system.

  - **addBotsWithName(PyObject loginInfo)**

    Immediately add a set of bots with login name and login password specified from loginInfo. The structure of the loginInfo is a list of tuples which consist of two strings. The first string is the login name and the second one is login password. In the event of incorrect loginInfo, a Python exception will be thrown.

  - **delBots(int numBots)** — Context: BigWorld

    Deletes the specified number of simulated clients from the application. The method onClientAppDestroy() of the personality module is called.

  - **getDefaultServer()** — Context: BigWorld

    Returns the server name that the bots try to log in.

  - **setDefaultServer(string serverName)** — Context: BigWorld

    Sets the server name that the bots try to log in.

  - **onTick()** — Context: BWPersonality

    This optional function is invoked every game tick, should it be defined in the personality module in <res>/server/bw.xml.

  - **onLoseConnection(int playerID)** — Context: BWPersonality

If this callback function is defined in the personality module specified in file <res>/server/bw.xml, it will be invoked when a simulated client loses its connection with a server abnormally. The personality script can decide whether the client should be destroyed or remain dormant for later reactivation by return True or False respectively. **NOTE**: if this callback is not defined, bots that lose connection will be automatically destroyed.

- **onClientAppDestroy(int playerID)** — Context: BWPersonality

  If defined in the personality module specified in file <res>/server/bw.xml, this callback method is called for each destroyed bot client. The argument is the ID of the deleted player entity. A bot client may be destroyed due to either loss of server connection or by BigWorld.delBots() method call. If a bot client is destroyed by BigWorld.delBots() method call, it will be disconnected from the server gracefully. We recommend client should execute additional log off procedure in this onClientAppDestroy callback function. An example is as following:

```
def onClientAppDestroyed( playerID ):
  bot = BigWorld.bots[playerID]
  if bot.isOnline:
    bot.entities[playerID].base.logOff()
```

The implementation above assumes that the player entity on the server has an exposed base method logOff(), which will then destroy the player cell and base entities on the server. The script must to be placed under the script folder `<res>/scripts/bot`.

8.4. Controlling Movement

The default movement controller Patrol moves the bots along a graph read from a file.

The name of the file containing the movement graph is specified in file <res>/server/ bw.xml, on section <bots>, by the configuration option controllerData.

```
<root>
  ...
  <bots>
    <controllerData>  server/bots/test.bwp  </controllerData>
    <controllerType>  Patrol                </controllerType>
    <password>        passwd                </password>
    <username>        Bot                   </username>
    <shouldLog>       true                  </shouldLog>
    <serverName>                            </serverName>
    <randomName>      false                 </randomName>
    <scripts>         false                 </scripts>
    <port>            0                     </port>
    <publicKey>       loginapp.pubkey       </publicKey>
  </bots>
  ...
</root>
```

Example file `<res>/server/bw.xml`

The file name might have the suffix random, in which case the start position of the bot is chosen randomly from the set of node positions in the graph.

The format specification for the movement graph file is illustrated below:

```
<controller>
```

```
  <nodeDefaults>
    ?NodeProperties
  </nodeDefaults>

  <nodes>
    *<node>
         <pos>   integer integer integer  </pos>
        ?<name>  string_node_name         </name>
        ?NodeProperties
        *<edges>
           <edge>  string_node_name  </edge>
         </edges>
     </node>
  </nodes>

</controller>
```

Grammar of movement graph files

The list below describes the tags in the movement graph file:

- **edge (section nodes/node/edges)**

  Name of one of the nodes that this node borders. Must be the same value specified for a name section in the file.

- **edges (section nodes/node)**

  Tag specifying all the nodes that this node borders.

- **name (section nodes/node)**

  Name used to refer to the node. If this tag is not specified for a node, then you can refer to it by an integer sequential number, with the first node having an index of zero.

- **node (section nodes)**

  Tag for section specifying a specific node in the graph.

- **nodeDefaults**

  Tag for section specifying default values for all nodes. These values can be overridden on a per-node basis in section nodes/node.

- **NodeProperties (section NodeDefaults and nodes/node)**

  For details, see “NodeProperties Section” on page 105 .

- **nodes**

  Tag for section specifying all the nodes in the graph.

- **pos (section nodes/node)**

  XYZ position of the centre of the node. The node is the area around pos, extending for n metres around it (n being the value of NodeProperties' tag radius).

8.4.1. NodeProperties Section

The format specification for the NodeProperties section is illustrated below:

```
?<minStay>   float  </minStay>
```

```
?<maxStay>   float  </maxStay>
?<radius>    float  </radius>
?<minSpeed>  float  </minSpeed>
?<maxSpeed>  float  </maxSpeed>
```

Grammar of **NodeProperties** section

The list below describes the tags in the `NodeProperties` section:

- **`maxSpeed`**

  Maximum speed of the bot.

- **`maxStay`**

  Maximum number of seconds that the bot should stay in the node.

- **`minSpeed`**

  Minimum speed of the bot.

- **`minStay`**

  Minimum number of seconds that the bot should stay in the node.

- **`radius`**

  Number of metres around the node's pos location to be considered as the node. When a bot is travelling between two nodes, it chooses a random point of arrival in the destination node. This way, the bots do not follow the exact same line. The point is chosen to lie within the radius of the destination node.

An example movement graph file is displayed below:

```
<patrolGraph>
  <nodeDefaults>
    <minStay>   5  </minStay>
    <maxStay>  10  </maxStay>
    <radius>   20  </radius>
  </nodeDefaults>
  <nodes>
    <node>
      <name>      Town1      </name>
      <minStay>   7          </minStay>
      <pos>       5000 0 0   </pos>
      <edges><edge>  Town2        </edge></edges>
    </node>
    <node>
      <name>      Town2        </name>
      <pos>       5000 0 5000  </pos>
    </node>
  </nodes>
</patrolGraph>
```

Example movement graph file

8.5. Extending Bots

8.5.1. Creating New Movement Controllers

The default movement controller is Patrol, but you might want to create one that better represents the expected traffic patterns and entity distributions of your game, or to stress test other aspects of the system.

To create a new movement Controller, derive its class from the MovementController class. Also derive a class from the MovementFactory class. The factory is used to parse the Controller data argument, and instantiate a new movement controller, while the movement controller moves the bot around.

The fragments below list the relevant methods in the base classes:

- **Class MovementController**

```
bool nextStep( float speed, float dTime, Vector3& position, Direction3D&
 direction)
```

- **Class MovementFactory**

```
MovementFactory(const char* name)

MovementController* create(
  const std::string&  data,
  const Vector3&      startPosition)
```

Chapter 9. Security

Security has been of paramount importance in the design and implementation of all parts of BigWorld.

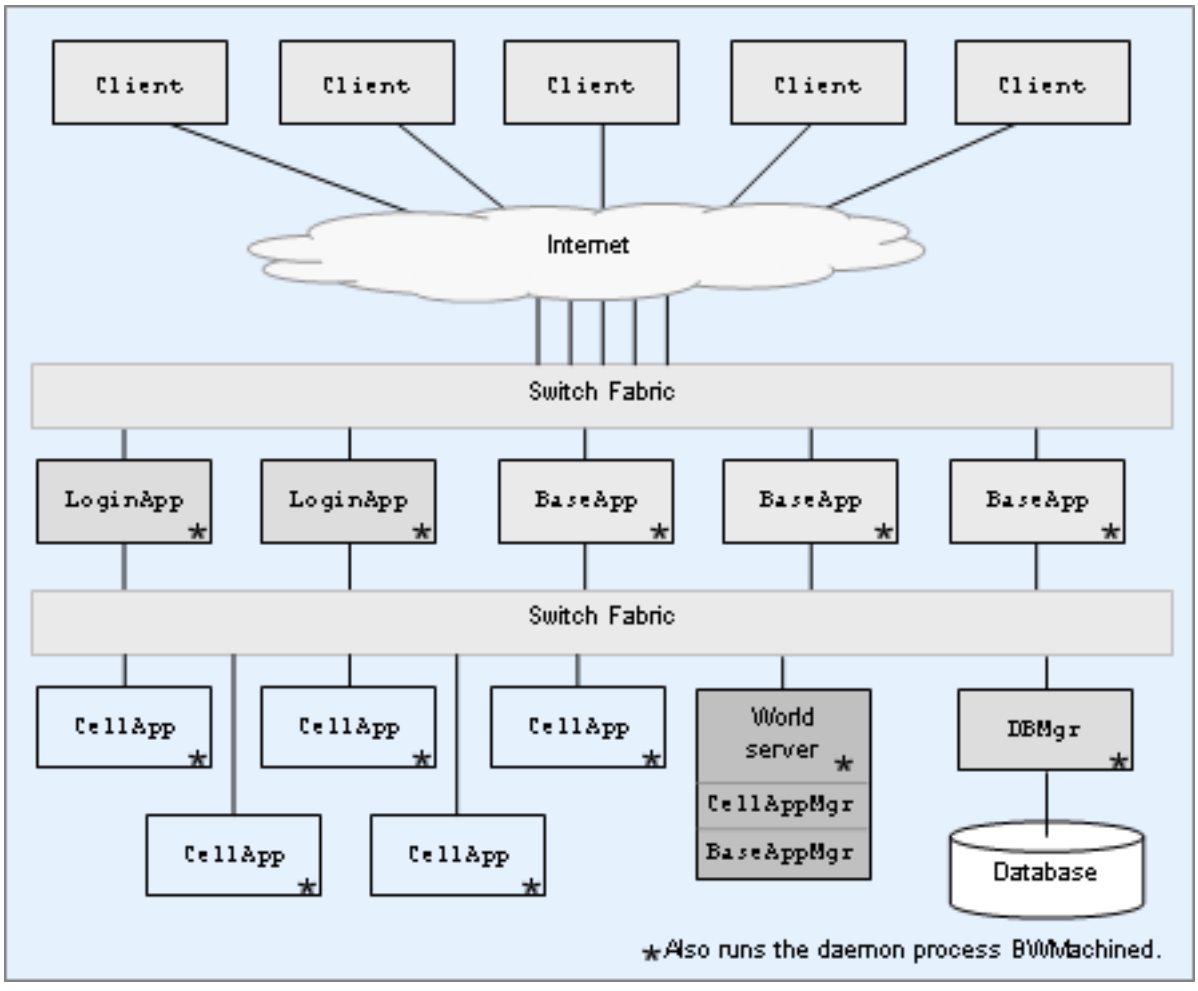
The basic philosophy is to always handle with care any client-initiated actions or messages. This should be accomplished in a way that does not unduly limit potential game designs.

For more details, see the document Server Programming Guide, chapter Security Systems in BigWorld Technology.

9.1. Security of the Server

The internal network is assumed to be secure — BigWorld does not implement security measures to safeguard processes against an attacker gaining access to the cluster's internal LAN. Operators should ensure that the usual protections for an internal network are in place. Remote access should be very strictly controlled.

The external points of contact are the area of most concern when running an exposed server. For BigWorld, these are LoginApp and BaseApp, as illustrated below:



BigWorld Server components

Due to the bandwidth needs of a massively multiplayer online game, LoginApp and BaseApp are intended to be run on machines with external access. In some sense they are the firewall. For more details, see “Blocking Ports and Related Security Considerations” on page 110 .

LoginApp receives only fixed-length queries, making it easy and transparent to secure. This process is expected to be tailored by customers to suit their game, but care should be taken when doing so.

BaseApp receives more complex data, including script method calls, and is the gateway to the rest of the BigWorld Server. It has many checks in place to ensure the integrity of received data, and to discard (and warn about) corrupted data and hacking attempts. The string CHEAT is used in the log messages when BigWorld receives potentially malicious data that does not conform to its protocols (the CellApp may also use this indicator.) It is advised that MessageLogger logs be monitored for messages containing that string (for details on MessageLogger, see “MessageLogger” on page 50).

The security of the game-level logic rests to a certain extent with the Python scripts that implement it. For example, an entity should not be able to stab another entity that is 100 metres away. For more details on this topic and on server features such as physics checking, see the document Server Programming Guide.

9.2. Server Ports

The list below describes the ports used by BigWorld server:

- **20013 (Protocol: UDP, Access: External)**

  Used by LoginApp, this port can be overridden in the following ways:

  - In `<res>/server/bw.xml` file's `loginApp` section, set the `port` configuration option.
  - In the command-line arguments to LoginApp, use the `-loginPort <portNum>` option.

- **20017 (Protocol: UDP, Access: Internal)**

  The HTTP interface of Watcher. To start the interface, run `bigworld/tools/server/watcher`, then connect to this port with a web browser.

- **20018 (Protocol: UDP, Access: Internal)**

  Used by BWMachined.

- **40001-49999 (Protocol: TCP, Access: Internal)**

  The Python server on BaseApp.

  All BaseApps have a Python server that can be telnetted to. The port number is 40000, plus the BaseApp ID.

  BaseApp ID numbers start at 1, so to talk to the third started BaseApp, telnet to 40003.

- **50001-59999 (Protocol: TCP, Access: Internal)**

  The Python server on CellApp.

  All CellApps have a Python server that can be telnetted to. The port number is 50000, plus the CellApp ID. CellApp ID number start at 1, so to talk to the third started CellApp, telnet to 50003.

  Note

  CellApp ID is not the same as the Cell ID. Cell IDs are allocated sequentially, as they are allocated to a cluster, not when the CellApp is started.

- **32768-61000 (Protocol: TCP, Access: Internal)**

  Used by CellAppMgr and CellApp for viewer applications such as Space Viewer. Automatically assigned by the kernel (see UDP entry).

- **32768-61000 (Protocol: UDP, Access: Internal [External for BaseApp])**

  Used by the server components: CellApp, CellAppMgr, BaseApp, BaseAppMgr, DBMgr, MessageLogger and StatLogger. Only the BaseApp has an external port.

  Automatically assigned by the kernel, in the range of the kernel setting `/proc/sys/net/ipv4/ip_local_port_range`, which defaults to 32768-61000.

  The BaseApp external port may be exempted from random assignment, by specifying it in the `<res>/server/bw.xml` file's `baseApp` section's `externalPort` configuration option.

  The port chosen can be displayed via the Watcher interface under:

  - `/(internal|external) nub/address` on BaseApp.
  - `/nub/address` on other components.

9.3. Blocking Ports and Related Security Considerations

Since TCP/IP is not used externally, you can block all TCP traffic. Leave all UDP/IP ports 32768 and above open, as well as the login port (20013 by default).

Use of a separate firewall machine is strongly discouraged. The BaseApp machines are designed to be the firewalls themselves, and perform a very similar proxying function for clients. Their amount of processing is small enough so that they can handle a whole network adapter's worth of Internet traffic. Adding another machine would only be a waste of hardware, maintenance time, and latency. BaseApps only listen on one UDP port — and so the whole TCP stack can be disabled on the external interface. The use of standard firewall software such as iptables may be an appropriate way to accomplish this.

Network tools such as lsof and netstat should be consulted, to ensure that you are not running any daemons listening on the external (or common) interface. Apart from BWMachined, you should not need to run any daemons with BigWorld, but if you wish to, then you should ensure that their ports are blocked. BWMachined should not listen on the external interface, only the internal interface.

Barring all TCP packets greatly improves the security of a BaseApp machine. TCP is a complicated protocol, and requires many tables and buffers to implement or firewall. By this rationale, the security of a BaseApp machine may be considered even better than that of an ordinary firewall, which must conditionally pass TCP packets.

To reduce exposure to DDOS attacks, it is recommended that the BaseApp be left to choose, within the range allocated by the operating system, a random port. This way, if an attacker discovers the IP and port of one of the BaseApp machines, then it does not mean he will automatically know those details for the other BaseApp machines.

Chapter 10. BigWorld Server Across Multiple Machines

To start a server cluster consisting of multiple machines, you can start each process in any of the following ways:

- the command line
- the `control_cluster.py` script
- WebConsole's ClusterControl module

CellApps, BaseApps, and LoginApps can have multiple instances running, while the other processes can have only one. The clients should connect to the IP address of a machine that is running a LoginApp.

10.1. How To Start

The following sub-sections describe how to start server components.

10.1.1. WebConsole

WebConsole can be used to easily start, stop and control server components.

For an outline of WebConsole, see “WebConsole” on page 45 . For operational behaviour, see the online WebConsole documentation in the Cluster Control module.

10.1.2. Auto Configuration Via `control_cluster.py`

The script `bigworld/tools/server/control_cluster.py` is generally the easiest way to start a multi-machine BigWorld Server. For details, see “`control_cluster.py`” on page 67 .

10.1.3. Hard-Coded Scripts

Create your own shell scripts using the script `bigworld/tools/server/misc/startsingle.sh` as a guide.

10.1.4. Manual Start

During development and testing, it is feasible to manually start processes individually.

10.2. How To Stop

The method used to stop the system depends on the method used to start it. For example, calling the script `control_cluster.py` with the option `stop` stops a system started with that script. Stopping LoginApp triggers other processes to terminate, unless this feature is disabled in configuration file `<res>/server/bw.xml`.

10.3. How To Monitor

Use WebConsole (for details, see “WebConsole” on page 45 .) and `control_cluster.py` (for details, see “`control_cluster.py`” on page 67 .) for monitoring and recording real-time statistics. You can also get profiling data from the watchers (via WebConsole's ClusterControl module). Use WebConsole's LogViewer module to monitor the centralised log.

10.4. LoginApp and Scalability

Just as you can use multiple CellApps and BaseApps in a large cluster, you can also run multiple LoginApps in a load sharing arrangement.

To do that, DNS has to set up so that it returns multiple DNS addresses for the login server's name. If you are using BIND, then you can simply put multiple A addresses in the zone configuration file. This means that when a client looks up the DNS address of the login server, it receives a login server randomly selected from the available pool.

For example, if you are using BIND as your DNS server (most Linux distributions come with BIND as their default DNS server), the zone file can have configuration similar to the ones in the table below:

Name	TTL	CLAS	TYPE	ResourceReco
login	600	IN	A	10.0.0.1
	600	IN	A	10.0.0.2
	600	IN	A	10.0.0.3

Example configuration on a BIND zone file

Because there are multiple A records with different IP addresses under one name, the IP address returned to a client when it looks up the address for the login server will be picked up from the IP address list, in a round robin manner.

Chapter 11. Multiple BigWorld Servers in a Single LAN

11.1. Keeping Processes Separate

All server components in a BigWorld server cluster run under the same UID. If you want to run multiple server clusters on the same network (for different stages of testing, for example), then make sure that you use different UIDs.

You also need to make sure that the LoginApps are on different machines. This is because by default each LoginApp opens the same specific port, and therefore only one could succeed in binding to it. Alternatively, multiple LoginApps can be run on a single machine as long as they have different port settings in <res>/server/bw.xml.

Note

It is important the username and UID mapping is consistent across all machines on the cluster. It is highly recommended to use centralised logins using LDAP or similar.

11.2. Centralised Cluster Monitoring

The best way to keep track of processes is via WebConsole's StatGrapher module.

The module, which can be run on any web browser, uses log files generated by StatLogger daemon to display statistics, and has a variety of options to filter the output by user.

For more details, see “StatGrapher” on page 47 , and “StatLogger” on page 55 .

11.3. Auto-Detection of LoginApps

When running multiple servers, it is convenient for the client to auto-detect LoginApp processes (this is only suitable for a development environment).

The LoginApps have this functionality built in, and do not require any configuration to perform it — they register themselves with BWMachined, and the client broadcasts a 'find' message to retrieve their contact details. A probe message is then sent to each server to determine who, where and what it is running. This functionality is implemented on the client by class `ServerDiscovery`.

Chapter 12. DBMgr MySQL Support

Following is described the minimal set of steps required to enable MySQL support for a server cluster. They assume that a MySQL database has been installed and configured as outlined in the Server Installation Guide, section Installing the BigWorld Server, Configure MySQL server.

12.1. Compiling DBMgr with MySQL Support

The DBMgr binary provided with the default BigWorld package does not have MySQL support built-in. This allows users to quickly start using BigWorld without having to configure a production database to test a simple package.

First, to enable compilation of DBMgr, make sure that the MySQL development files are installed on the build system. To do this, as root, issue:

- On Fedora:

```
yum install mysql-devel
```

- On Debian

```
apt-get install libmysql++-dev
```

Next, the DBMgr makefile needs to be modified, to enable MySQL support. Edit `bigworld/src/server/dbmgr/Makefile` and change the variable definition from **`USE_MYSQL=0`** to **`USE_MYSQL=1`** (`USE_XML` can be left on, without any side effects).

After these alterations, it will be possible to rebuild DBMgr. From within the `bigworld/src/server/dbmgr` folder, issue the command **make**.

12.2. Update `bw.xml` To Use MySQL

Once DBMgr has been compiled to communicate with a MySQL server, the game resource configuration file `<res>/server/bw.xml` needs to be updated with details on `username`, `password` and the `host` machine the MySQL server is running on.

The example below illustrates FantasyDemo configuration (via `fantasydemo/res/server/bw.xml`):

```
<dbMgr>
    <type>     mysql                     </type>
    <host>     my_mysql_server_machine </host>
    <username> bigworld </username>
    <password> my_pass </password>
    <databaseName>     fantasydemo </databaseName>
</dbMgr>
```

Example `fantasydemo/res/server/bw.xml`

For details on these fields and other relevant configuration options for your production environment, see *Server Configuration with `bw.xml`* on page 6 .

12.3. Initialise Database With Entity Definitions

DBMgr requires the MySQL database table structure to exactly match the current entity definitions.

To initialise the MySQL database with the correct structure, go to the folder containing the server binaries (*e.g.*, `mf/bigworld/bin/Hybrid`), then run DBMgr with the appropriate argument:

```
$ ./dbmgr --sync-tables-to-defs
```

When run with the `--sync-tables-to-defs` option, DBMgr updates the table structure and terminates, to allow the server to be started normally.

12.4. Disabling Schema-Modifying Capability

By default, DBMgr has the ability to alter the database schema through the `--sync-tables-to-defs` command-line option or the `<dbMgr>/<syncTablesToDefs>` configuration option. This feature may be undesirable in a production environment where the data in the database is highly valuable. Accidental use of the sync-tables-to-defs feature may result in data loss. For example, if the entity definition files were deleted, it will cause DBMgr to remove the corresponding tables in the database.

The schema-modifying capability of the DBMgr can be removed by recompiling it after setting the variable `ENABLE_TABLE_SCHEMA_ALTERATIONS` to `0` in `bigworld/src/server/dbmgr/Makefile`. The resulting DBMgr executable will no longer have the ability to modify the table schema. Use of the `--sync-tables-to-defs` command-line option or the `<dbMgr>/<syncTablesToDefs>` configuration option will result in a warning. The DBMgr will fail to start if the database table schema does not match the entity definitions.

The new DBMgr executable will be able to connect to a database with just the `SELECT`, `INSERT`, `UPDATE` and `DELETE` privileges. Please note that the original DBMgr executable required the `CREATE TABLE` privilege even when sync-tables-to-defs feature is not used. This is because the original DBMgr executable automatically creates and modifies BigWorld internal tables (tables with names starting with "bigworld").

It is likely that the original DBMgr executable with the sync-tables-to-defs feature will still be useful since manually updating the table schema to match the entity definition is a time consuming task. A copy of the original DBMgr executable can be kept at a location where it is not likely to be invoked in the day-to-day operations of a production server.

12.5. Enabling Secondary Databases

Secondary databases can only be enabled when MySQL support is enabled. Please see the document Server Programming Guide's chapter Secondary Databases for details about secondary databases.

To enable secondary database support, you must:

- Enable MySQL support (see above).
- Build the data consolidation tool by issuing the **make** command from within the `bigworld/src/server/tools/consolidate_dbs` directory.
- Set the `bw.xml` option `<baseApp>/<secondaryDB>/<enable>` to `true`.

Chapter 13. RPM

BigWorld provides a RPM implementation which allows the creation of binary RPM package for BWMachined. The RPM implementation uses the RPM system available in Linux distributions such as Fedora to generate RPM packages. Currently, the RPM implementation only supports building RPM packages on i386 architecture.

This chapter provides the following information:

- Directory structure and files related to BigWorld RPM implementation.
- How to generate BigWorld binary RPM packages.
- Customising RPM Packages.
- Setting up a `yum` repository.
- Install, upgrade and uninstall using `yum` command.
- How to obtain version number of an installed package.

13.1. Directory Structures and Files

The RPM implementation is located in the `bigworld/tools/server/rpm` directory:

- The `Makefile` is used to generate RPM packages.
- The `generate.py` is used to facilitate the creation of RPM packages.
- The `binary_rpms` directory is where generated RPM packages are placed.
- The `rpm` directory also contains package specific directories. For example, the `bwmachined` directory contains all the files specific to BWMachined.

13.2. How to Generate Binary RPM Packages

Binary RPM packages must be generated using a normal Unix user account. Binary RPM packages must not be generated using the root user.

Before generating RPM packages, the normal user used will need to be given read and write access to the the directory used by the RPM system to build the RPM packages. Run the following command to determine which directory is used by the RPM system to generate RPM packages:

```
$ rpm --eval %_topdir
```

To generate RPM package for BWMachined, go to the `rpm` directory and run the following command:

```
$ make
```

The generated RPM package will be placed in the `binary_rpms` directory.

The generated RPM package will have the following file name:

```
bigworld-bwmachined-<version>-<release>.i386.rpm
```

- The <version> field is the version number of the BigWorld release that the package was generated from. This field is based on the version number in `bigworld/res/version.xml`.
- The <release> field identifies the specific build of this RPM package. By default, it is not used and is mapped to `patch` number in `bigworld/res/version.xml`.

13.3. Customising RPM Packages

The most common customisation of a RPM package is the configuration file(s) installed by the package. That is, one RPM package may include the default configuration file and another may include a customised configuration file. These RPM packages can be distinguished by using the `release` field in the file name of these packages.

For example, the configuration file included in a BWMachined RPM package is located in `rpm/bwmachined/bwmachined.conf`.

To generate a BWMachined RPM package with the default configuration file and assign it the `release` number `0`:

- Use the `bwmachined.conf` provided by default.
- Update the `Release` tag in `rpm/bwmachined/bwmachined_template.spec` to the following:

```
Release: 0
```

- Generate the RPM package.

The file name of the RPM package generated will be, for example, `bigworld-bwmachined-1.9.1.0-0.i386.rpm`.

To generate a BWMachined RPM package with customised configuration file and assign it the `release` number `1`:

- Update the bwmachined.conf as required.
- Update the `Release` tag to `1`.
- Generate the RPM package.

The file name of the RPM package generated will be, for example, `bigworld-bwmachined-1.9.1.0-1.i386.rpm`.

13.4. Setting up a Yum Repository

For a large environment where RPM Packages, e.g. the BWMachined RPM Package, need to be installed on many machines, we recommend that a `yum` repository to be set up to provide these RPM packages. This allows an RPM package to be installed on any machine in the cluster by running the **yum** command without the need to manually copy the RPM package to each machine in the cluster.

The `yum` repository created will need to be made available through a web server such as the `Apache HTTP Server`. The setup required is outside the scope of this document. Please consult relevant web server documentation on how to achieve this.

Steps to set up a `yum` repository:

- On the machine that will be hosting the `yum` repository, create a directory for the BigWorld RPM packages. The location of this directory will depend on the web server chosen and the web server configuration which is outside the scope of this document.

- Copy the RPM packages to the directory created.
- Install the `createrepo` package using the following command:

```
$ yum install createrepo
```

This is a utility that will generate a common metadata repository from a directory of RPM packages.

Note

You will need to be the root user to install a package.

- Run the following command to create the necessary metadata for the `yum` repository:

```
$ createrepo <path_to_dir>
```

where <path_to_dir> is the path to the directory created.

For example, if the directory created is `/mnt/bigworld_repo`, then the command to run is the following:

```
$ createrepo /mnt/bigworld_repo
```

This creates a `repodata` directory in the `/mnt/bigworld_repo` directory.

- The `/etc/yum.conf` on a machine that will access the repository created will need to be updated to include the following setting:

```
[<repo_name>]
name=<repo_name>
baseurl=<url_to_repo>
enabled=1
```

where <repo_name> is replaced by the name given to the repository and <url_to_repo> is replaced by the URL that refers to the repository.

Note

By default, the `/etc/yum.conf` contains a `[main]` entry. The entry above should be added after the `[main]` entry.

When the `yum` repository is updated, for example, a new version of BWMachined RPM package is added, then the `repodata` directory should be deleted and the `createrepo` command should be run again to generate up-to-date metadata.

If a new RPM package was added to the repository but is not displayed on a machine when running a query command such as

```
$ yum info bigworld-bwmachined
```

run the following command to delete the metadata used by `yum` to determine the remote availability of packages:

```
$ yum clean meatadata
```

When the `yum` command is run the next time, it will download the up-to-date metadata.

13.5. Install, Upgrade and Uninstall using Yum Command

This section describes how to install, upgrade and uninstall using the `yum` command. The BWMachined package is used as an example.

13.5.1. Install and Upgrade using a RPM Package Directly

- To install a RPM Package directly without using `yum` repository:

  ```
  $ yum --nogpgcheck install bigworld-bwmachined-<version>-<release>.i386.rpm
  ```

  where `<version>` and `<release>` are replaced by the actual version and release number.

  This assumes that you are running the `yum` command in a directory containing the specified `.rpm` file.

  Note

  The RPM packages created by BigWorld RPM implementation are not signed, since these packages are from trusted source. Therefore, during installation and upgrade, GPG check is disabled.

- To upgrade a package:

  ```
  $ yum --nogpgcheck upgrade bigworld-bwmachined-<version>-<release>.i386.rpm
  ```

13.5.2. Install and Upgrade using Yum Repository

- To install a package from a `yum` repository:

  ```
  $ yum --nogpgcheck install bigworld-bwmachined
  ```

- To upgrade a package:

  ```
  $ yum --nogpgcheck upgrade bigworld-bwmachined
  ```

13.5.3. Remove an Installed Package

To remove an installed package:

```
$ yum remove bigworld-bwmachined
```

13.6. How to Obtain Version Number of an Installed Package

To obtain the version number of an installed package such as the BWMachined package, run the following command:

```
$ yum info bigworld-bwmachined
```

Chapter 14. First Aid After a Crash

If a BigWorld server component fails, then there are some steps that you should follow, to allow us to identify and resolve the problem as quickly as possible.

The first thing you should do is determine which component crashed first. There are many ways to do this — you can examine the logs or check the cores.

14.1. Procedure For Crash Reporting

A crash may be either intentional (an assert), or unintentional (such as segmentation fault). Intentional crashes are often due to errors in extensions, or unexpected use of script.

When you report a crash, be sure to include in your e-mail the following information:

- Backtrace The full call stack for the first process that crashed (use the bt command in gdb).
- Logs 50 lines before, and 50 lines after the crash (this can be obtained by issuing the command `mlcat.py --around <corefile> --context 50`), plus the last 50 lines of output generated by the process that crashed (this can be obtained by issuing the command `mlcat.py --around <corefile> --context 50 --filter pid <deadPID>`).

  If a more detailed investigation is required by BigWorld support staff, it is likely that it will be necessary to provide us with the actual raw log data generated at the time of the crash. The interactive segment selection mode of `mltar.py` (for details, see MessageLogger, “Command-Line Utilities” on page 52) is useful for archiving the necessary files before sending them.

It is not necessary to send any core files immediately, but do keep them so we can examine them later.

It is also very helpful if you give us access via ssh to a machine where we can examine the core dump, thus avoiding its time-consuming transmission over the Internet. This is also a good procedure because it allows us to verify that the correct executable binary is being used, which is an especially important check if you modified and relinked the executable, or have custom extensions, etc...

14.2. Q & A

Q: What if there is no core dump?

A: Some shells by default prevent the creation of core dumps. To change this default, before running BigWorld processes issue the command `'ulimit -c unlimited'`. This command sets resources limits — in this case it sets the core files to unlimited.

Q: How to determine the first process that crashed?

A: This is the information that could be used to determine that:

- Date on the core dump.
- Log message about the unexpected death of a process.
- '`restore`' messages in the backtrace.

Chapter 15. Common Log Messages

This section provides the description of common log messages.

15.1. Warnings

- ```
  CellApp    WARNING  WatcherDoc::initWatcherDoc: unable to load
   watcherdoc/cellapp.xml
  ```

  This `WARNING` is due to an incomplete feature to add documentation to our watchers. We apologise if it caused any confusion. You can silence this warning by creating `cellapp.xml` in `bigworld/res/watcherdoc`. The file should contain an empty `root` section:

  ```
  <root>
  </root>
  ```

- ```
  CellApp    WARNING  InterfaceElement::expandLength: Received a message
   longer than normal length
  ```

  We try to optimise network traffic by using the smallest integer size that can encode the expected length of the message. For example, if we expect the message to be always less than 255 bytes, we will use just one byte to encode the length. We use 2 bytes for messages that are expected to be less than 65535 bytes long, etc. However, if the message exceeds the expected size, we will fallback to using 4 bytes to encode the length. The above `WARNING` means that a message has exceeded the expected message length.

  Unfortunately, the `WARNING` does not tell us which message has exceeded the message length. We have added additional information to the `WARNING` in BigWorld 1.8.2.

- ```
  CellApp    WARNING  CellApp::handleGameTickTimeSlice: Last game tick took
  0.21 seconds
  ```

  This `WARNING` means that the game tick took longer than the normal 0.1 seconds. This can be due to many reasons but usually it is due to a script function taking a long time. You should ensure that your script code does not do anything that takes significant amount of time. You may have to break your processing into several runs by using a timer.

- ```
  CellApp    WARNING  CellApp: Scaling back!!
  ```

  In response to a game tick exceeding 0.1 seconds, the CellApp will skip some of its usual processing to help decrease the load, e.g. it will reduce the amount of updates sent to the client. This `WARNING` is to inform you that clients may receive less updates e.g. entity movements may be jerky.

- ```
  CellApp    WARNING  cellapp.cpp:1918: Profile CALL_TIMERS took 0.12 seconds
  ```

  This means that the total time of all `onTimer`() callbacks in that tick took 0.12 seconds. This is bad because one tick should be less than 0.1 seconds.

  ```
  CellApp    WARNING  cellapp.cpp:1572: Profile GAME_TICK took 0.12 seconds
  ```
  ```

This means the game tick took more than 0.1 seconds. This time includes the `CALL_TIMERS` time above so almost all of the game tick was in `onTimer`() callbacks.

```
CellApp    WARNING  Witness::update: 474 has a deficit of 2370 bytes (10.68
 packets)
```

This is related to the **`<bitsPerSecondToClient>`** configuration in `bw.xml`. If **`<bitsPerSecondToClient>`** is 20000, then it means that the maximum number of bytes we can send to the client every tick is `((20000/BitsPerSecond)/UpdateHertz) - UDPOverhead = ((20000/8)/10) - 28 = 222 bytes`. The above `WARNING` means that we are sending 2370 bytes to the client in one tick. This is 10.68 times the allowed data rate.

This is usually caused by method calls to the entities located on the client i.e. entities in the AoI of the player or the player itself. If many method calls are made, or if the method calls are passing large arguments, then we will exceed the bandwidth allocation for the client. When bandwidth allocation is exceeded, the position updates send to the client is reduced so entity movements will become jerky.

```
CellApp    WARNING  controller.cpp:158: Profile SCRIPT_CALL took 0.63
 seconds
CellApp    WARNING  Controller::standardCallback: method = onTimer; id =
 17648; controllerID = 270; userArg = 260
CellApp    WARNING  timer_controller.cpp:156: Profile ON_TIMER took 0.62
 seconds
```

The above 3 `WARNING`s are generated together. They mean a single `onTimer`() callback took 0.62 seconds. This is very bad since it means a single entity is using 6 times a normal game tick.

```
CellApp    WARNING  TimerController::New: Rounding up initial offset to 1
 from 0 (initialOffset 0.000000)
```

This means that you are adding a timer that is less than 0.1 seconds long. Our minimum timeout is 1 tick.

15.2. Errors

```
CellApp    ERROR    CellApp: Scale back exhausted. spareTime 0.016686
 tickPeriod 0.124365, real/entities 887/887, recvs 4504 trys 3958 good 0
 errs (546 sels), nub timers 753 calls 752 rescheds
```

The means that the game tick has exceeded 0.1 seconds for many ticks. The CellApp has already reduced updates to the clients to a minimum but still cannot keep the game tick shorter than 0.1 seconds.

```
CellApp    ERROR    Chunk::load: Failed to load chunk
 001xfffx/sep/0010fffco: unknown error in item 'model'
```

This means that there is an error loading a model in the chunk 0010fffco. Unfortunately, there is not enough information to identify what is causing the error. You can try loading the space in World Editor and see if the same error occurs. World Editor may be able to provide more information about the error.

- ```
  CellApp    ERROR    Received message id 41 for nonexistent entity 2844 from
   192.168.50.21:49140
  ```

  Message 41 is the `destroyEntity` message. This means that entity 2844 was already destroyed when the CellApp received this message. Make sure that you have not called "`self.destroy`()" in the cell and "`self.destroyCellEntity`()" in the base at the same time.

  This may also be an indication of a bug in BigWorld. If you are not able to resolve the issue, please send us more log output around the time of this error.

- ```
  CellApp    ERROR    DirMappingLoader::stepLoad: Stepping a loaded column

  CellApp    ERROR    DirMappingLoader::stepUnload: Unloading UNLOADED column
  ```

  Please ignore the above `ERROR` messages. They are not errors. We have removed these error messages in BigWorld 1.8.2.

- ```
  BaseApp    ERROR    BaseApp::setClient: Could not find base id 2881

  BaseApp    ERROR    getProxyForCall: No proxy set!

  BaseApp    ERROR    getProxyForCall: No proxy set!
  ```

  The above messages means that the entity (2881) has been destroyed but is still receiving messages. This may be due to another entity calling a method using a mailbox of the destroyed entity. You have to make sure that when an entity is destroyed, all other entities holding a mailbox to the destroyed entity is informed so that they can reset the mailbox.

  This may also be an indication of a bug in BigWorld. If you are unable to resolve the issue please send us more logs around the time of this error.

- ```
  BaseApp    ERROR    0.0.0.0:0: Exception was thrown: REASON_GENERAL_NETWORK
  ```

  This means that there was an error with the network. Either the machine has been disconnected from the network, or there is some sort of hardware error.

- ```
  BaseApp    ERROR    10.40.3.17:56859: Exception was thrown:
   REASON_NO_SUCH_PORT
  ```

  This means that either the machine has been disconnected from the network, or the destination process has crashed.
  ```

Chapter 16. Clock

The BigWorld server relies heavily on having an accurate clock for timers and load calculation. Unstable clocks (clocks that may move backward) can cause undesired behaviour and even crashes. Therefore properly configuring how BigWorld reads the time is essential for a stable, efficient server.

16.1. BigWorld Timing Methods

BigWorld provides three timing methods to select between. This can be configured by editing the file `/etc/bwmachined.conf` For example, to use the `gettime` timing method, include a section like this:

```
[TimingMethod]
gettime
```

- `rdtsc` reads the time stamp counter register on the CPU. It is by far the fastest and least stable method of deducing the current time. It is known to become unstable in multi-cored machines where a process moves between cores or if frequency scaling is used. In many systems however is completely stable and could therefore be used.
- `gettime` uses the kernel's clock driver to access the current time. It is far slower than rdtsc but has the ability to draw on multiple time sources to ensure a good compromise between speed, accuracy and stability is reachable. For additional system level configuration see: “Linux Clock Source” on page 125
- `gettimeofday` is a deprecated timing method. It is similar to gettime but has a lower theoretical maximum resolution and may be disrupted by NTP.

16.2. Linux Clock Source

Linux should automatically select an appropriate clock driver for its internal timekeeping, however at times the sysadmin may need to select a different one. If gettime is used as the timing method this will have a direct impact to how BigWorld behaves.

A user may check which clocksource they are using with the following command run as root:

```
#cat /sys/devices/system/clocksource/clocksource0/current_clocksource
```

You may check which options available with:

```
#cat /sys/devices/system/clocksource/clocksource0/available_clocksource
```

`tsc` and `jiffies` are known to be sometimes unstable and `acpi_pm` will also be unstable with some motherboard chipsets. We suggest you use `hpet` if it is available and if it isn't you should try `acpi_pm`.