

# Killerbeez API

GRIMM

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## 1 Overview

This document will cover the specific API of each module, along with a quick high-level summary of what it does.

The APIs are all specified in C, as this provides a consistent language and is explicit about data types which means there's no need for a separate Python specification. The C code is frequently wrapped with Python (via ctypes), but modules are typically written in C code as they run considerably faster when it is all native code.

## 2 Manager

The manager is what coordinates a fuzz job. It decides which seeds to use, which mutators to run and sends this information to the client, which kicks off one or more Main Fuzzers. The client will then also handle getting the results back to the manager.

## 3 Main Fuzzer

This will run many iterations of a single seed and a single mutator against a target program. For efficiency, this will be run on the same computer (which means same O/S) as the target binary. This component will be an executable that the manager executes on each of the target systems. The arguments for this function are defined in the usage function of the fuzzer.

## 4 Mutator

The mutator modules are what actually mutate the seed files. These would include things like a bit flipper, byte munger and so forth. They are given a seed file and optionally some state information. The state information is module-specific and allows the mutator to pick up where it left off. For example, the bit flipper mutator module, which simply flips one bit in the input file, would just need to record what bit to flip as their state. On the other hand, the byte munger will need to keep track of which byte it's modifying and what the new value is for that byte (e.g. stomp the fourth byte with 0x41). Additionally, each mutator will have a variety of configuration options that can be specified that will be mutator specific. Both the mutator state and options will be specified as JSON char arrays.

Anything which is mutator specific will only be used within the mutator functions. All other components will treat these items as opaque strings/blobs.

```
void init(mutator_t * m)
```

This function fills in m with all of the function pointers for this mutator. Note: This function only appears when compiled as a module. When

ALL\_MUTATORS\_IN\_ONE is defined, this function will not exist, as there would be a name collision with all the other `init()` functions from other modules and there will not be any need for obtaining this struct, as all the functions will just be called directly. It's just the code which uses modules which will want to use this struct. ALL\_MUTATORS\_IN\_ONE being defined will cause all the other functions to have the name of the mutator and an underscore prepended. This means that the `create()` function will be called `bit_flip_create()` in the bit flipper mutator. The name of the mutator is defined by `MUTATOR_NAME`.

- `m` - a pointer to a `mutator_t` structure that will be filled in with the function pointers that define this mutator.
- return value - none

```
void * create(char * options, char * state, char * input, size_t
input_length)
```

This function will allocate and initialize the mutator structure. The allocated structure will exist until the `cleanup()` function is called.

- `options` - a json string that contains the mutator specific string of options.
- `state` - used to load a previously dumped state (produced by the `get_state()` function), that defines the current iteration of the mutator. This will be a mutator specific JSON string. Alternatively, NULL can be provided to start a mutator without a previously dumped state.
- `input` - base input string which will be modified to produce mutated inputs later when the `mutate()` function is called
- `input_length` - the size of the input buffer
- return value - a mutator specific structure or NULL on failure. The returned value should not be used for anything other than passing to the various Mutator API functions.

```
void cleanup(void * mutator_state)
```

This function will release any resources that the mutator has open and free the mutator state structure.

- `mutator_state` - a mutator specific structure previously created by the `create()` function. This structure will be freed and should not be referenced afterwards.

```
int mutate(void * mutator_state, char * output_buffer, size_t buffer_length)
```

This function will mutate the input given in the `create()` function and return it in the `output_buffer` argument. The size of the `output_buffer` will be mutator specific. For example, some mutators may require this buffer to be larger than the original input (passed to the `create()` function) as it's going to extend the original input in some way. Other mutators will want it to be the same size. Guidance on this will be specified by the mutator specific documentation.

- `mutator_state` - a mutator specific structure previously created by the `create()` function.
- `output_buffer` - a buffer to which the mutated input will be written
- `buffer_length` - the size of the passed in buffer argument
- return value - the length of the mutated data, 0 when the mutator is out of mutations, or -1 on error

**`char * get_state(void * mutator_state)`**

This function will return the state of the mutator. The returned value can be used to restart the mutator at a later time, by passing it to the `create()` or `set_state()` function. It is the caller's responsibility to free the memory allocated here using the `free_state()` function.

- `mutator_state` - a mutator specific structure previously created by the `create()` function.
- return value - a buffer that defines the current state of the mutator. This will be a mutator specific JSON string.

**`void free_state(char * state)`**

This function will free a previously dumped state (via the `get_state()` function) of the mutator.

- `state` - a previously dumped state buffer obtained by the `get_state()` function.

**`int set_state(void * mutator_state, char * state)`**

This function will set the current state of the mutator. This can be used to restart a mutator once from a previous run.

- `mutator_state` - a mutator specific structure previously created by the `create()` function.
- `state` - a previously dumped state buffer obtained by the `get_state()` function. This will be a mutator specific JSON string.
- return value - 0 on success or non-zero on failure

```
int get_current_iteration(void * mutator_state)
```

This function will return the current iteration count of the mutator, i.e. how many mutations have been generated with it.

- mutator\_state - a mutator specific structure previously created by the create() function.
- return value - the number of previously generated mutations

```
int get_total_iteration_count(void * mutator_state)
```

This function will return the total possible number of mutations with this mutator. For some mutators, this value won't be possible to predict or the mutator will be capable of an infinite number of mutations.

- mutator\_state - a mutator specific structure previously created by the create() function.
- return value - the number of possible mutations with this mutator. If this number can't be predicted or is infinite, -1 will be returned.

```
int set_input(void * mutator_state, char * new_input, size_t input_length)
```

This function will set the input (saved in the mutator's state) to something new. This can be used to reinitialize a mutator with new data, without reallocating the entire state struct.

- mutator\_state - a mutator specific structure previously created by the create() function.
- new\_input - The new input used to produce new mutated inputs later when the mutate() function is called
- input\_length - the size in bytes of the input buffer.
- return value - 0 on success and -1 on failure

```
int help(char ** help_str)
```

This function sets a help message for the mutator. This is useful if the mutator takes a JSON options string in the create() function.

- help\_str - A double pointer that will be updated to point to the new help string.
- return value - 0 on success and -1 on failure

## 5 Driver

The driver will be the component that runs the program being fuzzed. The driver should start the program, feed in the input, and determine when the program is done processing the input. This component may need to be customized per target application.

Anything which is driver specific will only be used within the driver functions. All other components will treat these items as opaque strings/blobs.

```
void * create(char * options, instrumentation_t * instrumentation,  
void * instrumentation_state)
```

This function will allocate and initialize the driver structures. If the driver is going to be testing a long-running process, this function should start that process. Anything that needs to be done before a fuzzing run can start should be done here.

- options - a json string that contains the driver specific string of options.
- instrumentation - a pointer to an instrumentation instance that the driver will use to instrument the requested program. The caller should initialize this instrumentation instance before the create call to the driver, and then free it after cleaning up the driver.
- instrumentation\_state - a pointer to the instrumentation state for the passed in instrumentation.
- return value - a driver specific structure or NULL on failure. The returned value should not be used for anything other than passing to the various Driver API functions.

```
void cleanup(void * driver_state)
```

This function will kill any processes created by the driver and clean up anything else that was created to help fuzzing. It will also free the driver state.

- driver\_state - a driver specific structure previously created by the create function. This structure will be freed and should not be referenced afterwards.

```
int test_input(void * driver_state, char * buffer, size_t length)
```

This function will cause the program being fuzzed to be tested against the given input. This function should block execution until the program being fuzzed has finished processing the given input.

- driver\_state - a driver specific structure previously created by the create function.

- `buffer` - the input that should be tested
- `length` - the length of the buffer argument
- return value - 0 on success, non-zero on failure

## 6 Instrumentation

The instrumentation modules are what track the state of a process and determine if a path through the process is new. This will include things such as QEMU (for Linux), LLVM (for source), PIN, Dynamo-RIO, Dyninst, and Intel PT. They are optionally given some state information. The state information is module-specific and is used to tell the instrumentation module which paths have been previously hit. Additionally, each instrumentation module will have a variety of configuration options that can be specified that will be specific to that instrumentation module. These options will be specified as a JSON char array.

Anything which is instrumentation specific will only be used within the instrumentation functions. All other components will treat these items as opaque strings/blobs.

```
void * create(char * options, char * state)
```

This function will create and return an instrumentation struct that defines the instrumentation's state. The state argument will be used to load the previously executed paths through the fuzzed program.

- `options` - a JSON string that contains the instrumentation specific options
- `state` - used to load a previously dumped state (produced by the `get_state()` function), that defines the current paths seen by the instrumentation. Alternatively, NULL can be provided to start an instrumentation without a previously dumped state
- return value - an instrumentation specific structure or NULL on failure. The returned value should not be used for anything other than passing to the various Instrumentation API functions

```
void cleanup(void * instrumentation_state)
```

This function will release any resources that the instrumentation has open and free the instrumentation state.

- `instrumentation_state` - an instrumentation specific structure previously created by the `create` function. This structure will be freed and should not be referenced afterwards



```
char * get_state(void * instrumentation_state, int *out_length)
```

This function will return the state information holding the previous execution path info. The returned value can later be passed to the instrumentation create() function to load the state back into an instrumentation struct. It is the caller's responsibility to free the memory allocated and returned here using the free\_state() function.

- instrumentation\_state - an instrumentation specific structure previously created by the create function
- out\_length - this pointer will be filled with the length of the returned state buffer
- return value - a buffer that holds information about the previous execution paths as a JSON char array.

```
void free_state(char * state)
```

This function will free a previously dumped state (via the get\_state() function) of the instrumentation.

- state - a previously dumped state buffer obtained by the get\_state() function

```
int set_state(void * instrumentation_state, char * state)
```

This function will set the previous execution paths of the instrumentation. This can be used to restart an instrumentation once it has been created.

- instrumentation\_state - an instrumentation specific structure previously created by the create() function
- state - a previously dumped state buffer obtained by the get\_state() function
- return value - 0 on success or non-zero on failure

```
void * merge(void * instrumentation_state, void * other_instrumentation_state)
```

This function will merge two sets of instrumentation coverage data. The resulting instrumentation state will include the tracked coverage from both instrumentation states. Both instrumentation states must have the same instrumentation options (what to track coverage of, which modules, etc.) specified, and generally need to be produced by the same instrumentation module in order for the merge to work correctly. It's possible that two different instrumentation modules may produce state information in the same format, however this is up to them and not something guaranteed by this specification. Neither argument will be modified nor freed. It is the caller's responsibility to free the memory allocated and returned here using the free\_state() function.

- instrumentation\_state - an instrumentation specific structure previously created by the create() function
- other\_instrumentation\_state - a second instrumentation specific structure previously created by the create() function that should be merged with the first
- return value - an instrumentation specific structure that combines the coverage information from both of the instrumentation states or NULL on failure

```
int enable(void * instrumentation_state, HANDLE * process, char *
cmd_line, char * input, size_t input_length)
```

This function will enable the instrumentation module for a specific process and runs that process. If the process needs to be restarted, it will be.

- instrumentation\_state - an instrumentation specific structure previously created by the create() function
- process - a pointer to a handle for the process on which the instrumentation was enabled
- cmd\_line - the command line of the fuzzed process on which to enable instrumentation
- input - pointer to the buffer containing the input data that should be sent to the fuzzed process
- input\_length - the length of the input parameter
- return value - 0 on success, non-zero on failure

```
int is_new_path(void * instrumentation_state, int * process_status)
```

This function will determine whether the process being instrumented has taken a new path. It should be called after the process has finished processing the tested input.

- instrumentation\_state - an instrumentation specific structure previously created by the create() function
- process\_status - pointer that will be filled with a value representing whether the fuzzed process crashed or hung, or neither
- return value - 1 if the previously setup process (via the enable() function) took a new path, 0 if it did not, or -1 on failure

```
int get_module_info(void * instrumentation_state, int index, int
* is_new, char ** module_name, char **info, int size)
```

This function is optional and not required for the fuzzer to work. It can be used to obtain coverage information for each executable/library separately. This function returns information about each of the separate modules (shared libraries such as .dll, .so, .dynlib).

- instrumentation\_state - an instrumentation specific structure previously created by the create() function
- index - an index into the module list for the module about which information should be retrieved. The return value will indicate if a module exists for this index. Indices start at 0 and increase from there
- is\_new - This parameter returns whether or not the last run of the instrumentation returned a new path for the module with the specified index. In order for the information returned in this parameter to be accurate, the is\_new\_path method should be called first. This parameter is optional and can be set to NULL, if you do not want this information
- module\_name - This parameter returns the filename of the module at the specified index. This parameter is optional and can be set to NULL, if you do not want this information. This parameter should not be freed by the caller
- info - This parameter returns the per-instrumentation path info for the module with the specified index. For example, for the DynamoRIO module, the returned info is an AFL style bitmap of the edges. This parameter is optional and can be set to NULL, if you do not want this information. This parameter should not be freed by the caller
- size - This parameter returns the size of the per-instrumentation path info in the returned info parameter. This parameter is optional and can be set to NULL, if you do not want this information
- return value - non-zero if module with the specified index cannot be found, or 0 if it is found

```
instrumentation_edges_t * get_edges(void * instrumentation_state,
int index)
```

This function is optional and not required for the fuzzer to work. It is used by the tracer. This function returns an array of basic block edges that occurred in the most recent run of the instrumentation.

- instrumentation\_state - an instrumentation specific structure previously created by the create() function.

- index - If per-module instrumentation information is enabled, this parameter is an index into the module list for the module about which edges should be retrieved. The return value will indicate if a module exists for this index. Indices start at 0 and increase from there. If per-module instrumentation information is NOT enabled, then this parameter is ignored and the general edges array will be returned.
- return value - NULL if an array of basic block edges was not tracked for the most recent instrumentation run or per-module instrumentation is enabled and the requested index was not found. Otherwise, an instrumentation\_edges\_t pointer that contains an array of basic block edges that were hit in the most recent instrumentation run. The returned pointer should be freed by the caller.