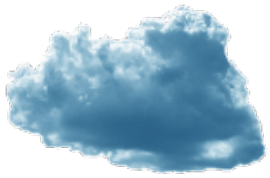
CloudI 

CloudI API Documentation

version 1.3.1b

last updated on February 1st 2014

CloudI API - Making a Service

CloudI Service API - Controlling CloudI

CloudI API - Making a Service

1.0 - Introduction

The CloudI API provides a simple messaging API which allows CloudI services to send requests. So, the CloudI API contains messaging primitives that can be used to emulate other messaging APIs, but normally the CloudI API is used directly. The CloudI API supports both publish/subscribe and request/reply communication in an intuitive way. It is not necessary to understand the Erlang programming language, to use the CloudI API since a full CloudI API implementation is provided for every supported programming language (Erlang, C/C++, Java, Python, and Ruby, currently).

The CloudI API messaging is different from other messaging APIs and provides simpler integration for a few reasons:

- The CloudI service that receives a request determines whether a reply occurs (returning no response data is the same as not providing a reply)
- All required callbacks are minimal (only a single request callback is necessary for a CloudI service to handle requests) to keep CloudI services simpler, so they are less error-prone than other solutions
- Requests are not persisted to database storage to avoid persisting errors since errors are often transient and only relate to a specific context
- All CloudI API programming language integration makes CloudI services first-class actors within the Erlang VM's actor model to provide consistent

functionality and fault-tolerance
- Every CloudI API request contains a priority
- Every CloudI API request contains a unique v1 UUID for identifying the request and its response
- Every CloudI API request contains a timeout which is updated based on the queuing and processing delays the request encounters

The subscribe function subscribes to a service name pattern which can contain "*" wildcard characters, to accept any matching service requests. "*" within a service name pattern matches 1 or more characters, but "**" is forbidden. The send_sync function and the send_async function provide point-to-point communication based on the service name provided. When multiple services subscribe with the same service name pattern the destination is picked based on the sending service's "destination refresh method", which can be any of the following:

Destination Refresh Method	Meaning
lazy_closest (or) immediate_closest	A service running on the local node will be selected, unless the destination only exists on a remote node
lazy_furthest (or) immediate_furthest	A service running on a remote node will be selected, unless the destination only exists on the local node
lazy_random (or) immediate_random	A service is selected randomly from the subscribed services
lazy_local (or) immediate_local	Only a service on the local node is selected
lazy_remote (or) immediate_remote	Only a service on a remote node is selected
lazy_newest (or) immediate_newest	Only the most recently subscribed service is selected
lazy_oldest (or) immediate_oldest	Only the first subscribed service is selected
none	The service should never send a request and it is an error when the service attempts to send (the service may still receive requests)

The "lazy" prefix and the "immediate" prefix on the destination refresh method determines whether stale data is used within the service's data or if a

single Erlang lookup process is used to get the most current destination result, respectively ("lazy" is for when long-lived services are the destination but consumes more service memory, and "immediate" is for when short-lived services are the destination but creates contention for the Erlang lookup process).

When separate service processes subscribe with the same service name pattern, each subscription is used based on random selection (if both service processes are available based on the destination refresh method), when a service request is sent to the service name. If the same service subscribes with the same service name pattern more than once within a single external service thread, each subscription is used in round-robin order (first subscription is called first, so order is preserved), when the service thread receives a request for the specific service name pattern.

The mcast_async function provides publish functionality by sending a request asynchronously to all services that have subscribed to the same service name pattern. To receive an asynchronous request recv_async is used with the "TransId" (i.e., Transaction Id, a v1 UUID) or a null UUID to receive the oldest service request.

The return function is used to respond to a service request and terminate the current request handler (i.e., the service request is finished, at that point). A service can return a null response if the sending service should not receive a response, which can be used for typical response-less publish functionality. The forward function provides a new destination for the same service request, delaying the request's completion, but still terminating the current request handler.

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1.1 - (initialization)

The service configuration will control the CloudI API initialization, which is done automatically, but does influence the source code. The service configuration defines the number of Operating System (OS) processes to create and the number of threads for an external (non-Erlang) service. For an internal (Erlang) service, the configuration defines the number of Erlang processes to create. A number specified as an integer in the configuration is the exact number of processes or threads. However, if the number is specified as a floating point number, it is used as a CPU count (i.e., Erlang scheduler count) multipler where >1.0 implies floor and <1.0 implies round. The external service APIs provide the thread_count function so that the total number of threads can be used for thread creation, with each thread holding an instance

of the CloudI API (to avoid lock contention):

Programming Language	Function Call
C	`int cloudi_initialize_thread_count(unsigned int * const threa`
C++	`unsigned int CloudI::API::thread_count();`
Java	`int org.cloudi.API.thread_count();`
Python	`cloudi_c.API.thread_count()` `cloudi.API.thread_count()`
Ruby	`CloudI::API.thread_count()`

The service configuration also allows Access Control Lists (ACLs) to define explicit service name patterns for allowing or denying service destinations when the service sends a service request. The ACLs along with the destination refresh method determine how service requests are sent while other service options can tweak default settings.

External (non-Erlang) services are provided both the command line and the environmental variables specified within the service configuration. External sevice configuration uses the full path to the executable while internal services use the module name (and the OTP application name) within the code search paths. All environmental variables set in the shell executing the Erlang VM can be used within the executable path, arguments and environment set in the configuration of an external service, using standard shell syntax (e.g., "${USER}" or "$USER", where "\\$" is a literal "$" character).

Please see the CloudI Service API (services_add) for more details about service configuration.

Specific Language Integration Notes:

The Erlang CloudI API functions shown below accept the most function parameters in cloudi_service but functions with less parameters do exist and they utilize default values for timeouts and request priority. Both the Timeout parameter and the Priority parameter accept the 'undefined' atom to assign the default configured value. Please see the cloudi_service module to see all the available functions and the behavior interface functions that are implemented within an Erlang service. The cloudi_service module is used

within CloudI services, however, it is also possible to use CloudI services from external Erlang processes with a subset of the CloudI API functions in the cloudi module.

Both the C and the C++ CloudI API rely on the same underlying code, with the C++ API object as a wrapper around the C API pointer, so there should be no large performance difference. STL is avoided, to avoid the libstdc++ memory pool and internal memory pools are used. The C++ CloudI API functions below use the STRING type to represent either char const * const (or) std::string const &, since both are supported with overloaded functions.

The Java CloudI API doesn't have any C or C++ integration. It only uses reflection to utilize the low-level file descriptor object and store object function pointers.

The python CloudI API is provided as both the "cloudi" module and the "cloudi_c" module. The "cloudi_c" module uses the C++ CloudI API for more efficiency, while the "cloudi" module only uses Python source code.

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1.2 - subscribe

Programming Language	Function Call
Erlang	`cloudi_service:subscribe(Dispatcher :: pid(), Pattern :: stri` `ok.`

C	`int cloudi_subscribe(cloudi_instance_t * p,`
	`char const * const pattern,`
	`cloudi_callback_t f);`

C++	`template <typename T>`
	`int CloudI::API::subscribe(STRING pattern,`
	`T & object,`
	`void (T::*f) (CloudI::API const &,`
	`int const,`
	`STRING,`
	`STRING,`
	`void const * const,`
	`uint32_t const,`
	`void const * const,`
	`uint32_t const,`
	`uint32_t,`

```
                                                int8_t,
                                                char const * const,
                                                char const * const,
                                                uint32_t const)) cons
int CloudI::API::subscribe(STRING pattern,
                           void (*f) (API const &,
                                      int const,
                                      STRING,
                                      STRING,
                                      void const * const,
                                      uint32_t const,
                                      void const * const,
                                      uint32_t const,
                                      uint32_t,
                                      int8_t,
                                      char const * const,
                                      char const * const,
                                      uint32_t const)) const
```

Java

```
void org.cloudi.API.subscribe(final String pattern,
                              final Object instance,
                              final String methodName);
```

Python

```
cloudi_c.API.subscribe(pattern, Function)
cloudi.API.subscribe(pattern, Function)
```

Ruby

```
CloudI::API.subscribe(pattern, function)
```

Subscribes with a service name pattern which provides a destination for other services to send to. The subscribing service will receive a service request, if a different service sends a service request with a service name that matches the service name pattern. The service name pattern is a string that may contain a "*" wildcard character to match 1 or more characters, while "**" is forbidden. The service names and service name patterns are expected to be in a filepath format (e.g., "/root/directory/file.extension") by some provided CloudI services, though nothing enforces this convention. Good design dictates that service names operate within a given scope. Both the service names and the service name patterns should represent an appropriate scope, which the service manages (i.e., the same concept as a Uniform Resource Identifier (URI)).

When a service subscribes to a service name pattern, the supplied pattern string is appended to the service name prefix from the service's configuration, to provide the full service name pattern. The prefix provided

within the service's configuration declares the scope of all service operations, as they are seen from other running services. Multiple subscribe function calls can increase the probability of receiving a service request when other services are subscribed with the same service name pattern.

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1.3 - unsubscribe

Programming Language	Function Call
Erlang	`cloudi_service:unsubscribe(Dispatcher :: pid(), Pattern :: st` `ok.`
C	`int cloudi_unsubscribe(cloudi_instance_t * p,` `char const * const pattern);`
C++	`int CloudI::API::unsubscribe(STRING pattern) const;`
Java	`void org.cloudi.API.unsubscribe(final String pattern);`
Python	`cloudi_c.API.unsubscribe(pattern)` `cloudi.API.unsubscribe(pattern)`
Ruby	`CloudI::API.unsubscribe(pattern)`

Unsubscribe will remove the service's subscription for the specific service name pattern. If a service has subscribed with the same service name pattern multiple times, the unsubscribe will only remove one subscription instance. The subscription instance which is removed is whatever subscription would have been called next, for a matching service request.

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1.4 - get_pid (Erlang-only)

Programming Language	Function Call

Erlang	`cloudi_service:get_pid(Dispatcher :: pid(),`
	`Name :: string(),`
	`Timeout :: non_neg_integer() |`

```
                                        'undefined' | 'immediate') ->
    {'ok', PatternPid :: {string(), pid()}} |
    {'error', Reason :: atom()}.
```

Internal (Erlang-only) services can request an Erlang process based on the service name provided, before calling either the send_sync function or the send_async function. The get_pid function should rarely be necessary, but it can allow other logic to be used for determining which service should receive a request (e.g., based on apparent processing power, like within the hexpi test). The Erlang PatternPid tuple returned could become invalid if the service destination terminated, so the Erlang process monitoring becomes the burden of the get_pid function user. Due to the intimate nature of this function, it only exists within the Erlang CloudI API (to implement it in other languages would cause service destination inconsistencies due to the function delay and the potential storage before the destination is used).

The get_pid function provides a way to split the service name lookup latency from the service request latency so that two separate timeout values can be used, instead of a single timeout.

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1.5 - get_pids (Erlang-only)

Programming Language	Function Call

Erlang	`cloudi_service:get_pids(Dispatcher :: pid(),`
	`Name :: string(),`
	`Timeout :: non_neg_integer() |`
	`'undefined' | 'immediate')`
	`{'ok', PatternPids :: list({string(), pid()})} |`
	`{'error', Reason :: atom()}.`

Internal (Erlang-only) services can request a list of Erlang processes based on the service name provided, before calling either the send_sync function or the send_async function. If all Erlang processes returned need to be used with send_async, it is easier to use the mcast_async function. The get_pids function should rarely be necessary, but it can allow other logic to be used for determining which service should receive a request (e.g., based on apparent processing power, like within the hexpi test). The Erlang PatternPids tuple list returned could contain invalid Erlang processes if the service

destination terminated, so the Erlang process monitoring becomes the burden of the get_pids function user. Due to the intimate nature of this function, it only exists within the Erlang CloudI API (to implement it in other languages would cause service destination inconsistencies due to the function delay and the potential storage before the destination is used).

The get_pids function provides a way to split the service name lookup latency from the service request latency so that two separate timeout values can be used, instead of a single timeout (e.g., with mcast_async).

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1.6 - send_sync

Programming Language	Function Call

Erlang	`cloudi_service:send_sync(Dispatcher :: pid(),`
	`  Name :: string(),`
	`  RequestInfo :: any(),`
	`  Request :: any(),`
	`  Timeout :: non_neg_integer() |`
	`  'undefined' | 'immediate',`
	`  Priority :: integer() | 'undefined')`
	`  {'ok', ResponseInfo :: any(), Response :: any()} |`
	`  {'ok', Response :: any()} |`
	`  {'error', Reason :: atom()}.`
	`cloudi_service:send_sync(Dispatcher :: pid(),`
	`  Name :: string(),`
	`  RequestInfo :: any(),`
	`  Request :: any(),`
	`  Timeout :: non_neg_integer() |`
	`  'undefined' | 'immediate',`
	`  Priority :: integer() | 'undefined',`
	`  PatternPid :: {string(), pid()}) ->`
	`  {'ok', ResponseInfo :: any(), Response :: any()} |`
	`  {'ok', Response :: any()} |`
	`  {'error', Reason :: atom()}.`

C	`int cloudi_send_sync_(cloudi_instance_t * p,`
	`  char const * const name,`
	`  void const * const request_info,`
	`  uint32_t const request_info_size,`
	`  void const * const request,`
	`  uint32_t const request_size,`
	`  uint32_t timeout,`
	`  int8_t const priority);`

Send a synchronous request to a service name with a specific timeout and a specific priority. If a timeout is not provided, the default synchronous timeout from the service configuration is used. If a priority is not provided, the default priority from the service configuration options is used (normally the default priority is 0).

Function Return Values:

Programming Language	Return Value

Erlang	ResponseInfo is only returned if it does not equal <<>>. Respons returned if it does not equal <<>>.
	`{'ok', ResponseInfo :: any(), Response :: any()}`
	`{'ok', Response :: any()}`
	`{'error', Reason :: atom()}`

C	Separate functions are provided to get the function result after a successful send_sync function call (an integer 0 return value).
	`cloudi_get_response(p)`
	`cloudi_get_response_size(p)`
	`cloudi_get_response_info(p)`
	`cloudi_get_response_info_size(p)`
	`cloudi_get_trans_id_count(p)`
	`cloudi_get_trans_id(p, i)`

C++	Separate functions are provided to get the function result after a successful send_sync function call (an integer 0 return value).
	`char const * CloudI::API::get_response() const;`
	`uint32_t CloudI::API::get_response_size() const;`
	`char const * CloudI::API::get_response_info() const;`
	`uint32_t CloudI::API::get_response_info_size() const;`
	`uint32_t CloudI::API::get_trans_id_count() const;`
	`char const * CloudI::API::get_trans_id(unsigned int const i =`

Java	A class encapsulates the function result. `org.cloudi.API.Response`
Python	A tuple provides the function result. `(response_info, response, trans_id)`

Ruby	An array provides the function result. `[response_info, response, trans_id]`

The send_sync response data is provided in ways typical to each programming language, as shown above. The non-Erlang send_sync functions provide the TransId of the request because the calling service may need to use the v1 UUID to manipulate and/or store the response.

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1.7 - send_async

Programming Language	Function Call
Erlang	`cloudi_service:send_async(Dispatcher :: pid(),` `  Name :: string(),` `  RequestInfo :: any(),` `  Request :: any(),` `  Timeout :: non_neg_integer() |` ` 'undefined'	'immediate` ` Priority :: integer()	'undefined'` ` {'ok', TransId :: <<_:128>>} |` ` {'error', Reason :: atom()}.` `cloudi_service:send_async(Dispatcher :: pid(),` ` Name :: string(),` ` RequestInfo :: any(),` ` Request :: any(),` ` Timeout :: non_neg_integer() |` ` 'undefined'	'immediate` ` Priority :: integer()	'undefined',` ` PatternPid :: {string(), pid()}) ->` ` {'ok', TransId :: <<_:128>>} |` ` {'error', Reason :: atom()}.` `cloudi_service:send_async_passive(Dispatcher :: pid(),` ` Name :: string(),` ` RequestInfo :: any(),` ` Request :: any(),` ` Timeout :: non_neg_integer()` ` 'undefined'	'i` ` Priority :: integer()	'un` ` {'ok', TransId :: <<_:128>>} |` ` {'error', Reason :: atom()}.` `cloudi_service:send_async_passive(Dispatcher :: pid(),` ` Name :: string(),`

```
                                    RequestInfo :: any(),
                                    Request :: any(),
                                    Timeout :: non_neg_integer()
                                               'undefined' | 'in
                                    Priority :: integer() | 'und
                                    PatternPid :: {string(), pid
    {'ok', TransId :: <<_:128>>} |
    {'error', Reason :: atom()}.
```

C

```
int cloudi_send_async_(cloudi_instance_t * p,
                       char const * const name,
                       void const * const request_info,
                       uint32_t const request_info_size,
                       void const * const request,
                       uint32_t const request_size,
                       uint32_t timeout,
                       int8_t const priority);
```

C++

```
int CloudI::API::send_async(STRING name,
                            void const * const request_info,
                            uint32_t const request_info_size,
                            void const * const request,
                            uint32_t const request_size,
                            uint32_t timeout,
                            int8_t const priority) const;
```

Java

```
TransId org.cloudi.API.send_async(String name, byte[] request_
                                  byte[] request, Integer time
                                  Byte priority);
```

Python

```
cloudi_c.API.send_async(name, request,
                        timeout=None, request_info=None, prio
cloudi.API.send_async(name, request,
                      timeout=None, request_info=None, priorit
```

Ruby

```
CloudI::API.send_async(name, request,
                       timeout=nil, request_info=nil, priority
```

Send an asynchronous request to a service name with a specific timeout and a specific priority. If a timeout is not provided, the default asynchronous timeout from the service configuration is used. If a priority is not provided, the default priority from the service configuration options is used (normally the default priority is 0).

An asynchronous send will block until a live service matches the service

name destination or the timeout expires. Once the asynchronous request is sent the TransId which identifies the request is returned.

Function Return Values:

Programming Language	Return Value
Erlang	`{'ok', TransId :: <<_:128>>}` `{'error', Reason :: atom()}`

C	Separate functions are provided to get the function result after a successful send_async function call (an integer 0 return value).
	`cloudi_get_trans_id_count(p)`
	`cloudi_get_trans_id(p, i)`

C++	Separate functions are provided to get the function result after a successful send_async function call (an integer 0 return value).
	`uint32_t CloudI::API::get_trans_id_count() const;`
	`char const * CloudI::API::get_trans_id(unsigned int const i =`

Java	A class encapsulates the function result. `org.cloudi.API.TransId`
Python	The trans_id is a string of 16 bytes. `trans_id`
Ruby	The trans_id is a string of 16 bytes. `trans_id`

The send_async result is provided in ways typical to each programming language, as shown above. A TransId is a v1 UUID.

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1.8 - send_async_active (Erlang-only)

Programming Language	Function Call

Erlang	`cloudi_service:send_async_active(Dispatcher :: pid(),`
	`  Name :: string(),`
	`  RequestInfo :: any(),`
	`  Request :: any(),`
	`  Timeout :: non_neg_integer()`
	`  'undefined' | 'imm`
	`  Priority :: integer() | 'unde`
	`  {'ok', TransId :: <<_:128>>} |`
	`  {'error', atom()}.`
	`cloudi_service:send_async_active(Dispatcher :: pid(),`
	`  Name :: string(),`
	`  RequestInfo :: any(),`
	`  Request :: any(),`
	`  Timeout :: non_neg_integer()`
	`  'undefined' | 'imm`
	`  Priority :: integer() | 'unde`
	`  PatternPid :: {string(), pid(`
	`  {'ok', TransId :: <<_:128>>} |`
	`  {'error', atom()}.`

The send_async_active function provides the same functionality as the send_async function within an Erlang process, but the response is automatically sent to the Erlang process, after completion. Using send_async_active is the preferred way to send an asynchronous service request in Erlang because it utilizes Erlang's concurrency without requiring a blocking operation (a passive send, using Erlang vernacular, since it would otherwise require a call of the function recv_async to receive the request). The send_async_active function is not implemented in other languages because of their lack of a native Actor Model.

Incoming Process Message:

Programming Language	Messages

Erlang	`{'return_async_active', Name :: string(), Pattern :: string(),`
	` ResponseInfo :: any(), Response :: any(),`
	` Timeout :: non_neg_integer(), TransId :: <<_:128>>}`
	`{'timeout_async_active', TransId :: <<_:128>>}`

The send_async_active message is sent to the Erlang process as an

Erlang message, so it arrives in the cloudi_service_handle_info function of the Erlang service module (i.e., the module that implements the cloudi_service behavior). The message formats are also provided as records that are accessible with:

```
-include_lib("cloudi_core/include/cloudi_service.hrl").
```

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1.9 - mcast_async

Programming Language	Function Call

Erlang	`cloudi_service:mcast_async(Dispatcher :: pid(),`
	`  Name :: string(),`
	`  RequestInfo :: any(),`
	`  Request :: any(),`
	`  Timeout :: non_neg_integer() |`
	`  'undefined' | 'immediate`
	`  Priority :: integer() | 'undefined`
	`  {'ok', TransIdList :: list(<<_:128>>)} |`
	`  {'error', Reason :: atom()}.`

C	`int cloudi_mcast_async_(cloudi_instance_t * p,`
	`  char const * const name,`
	`  void const * const request_info,`
	`  uint32_t const request_info_size,`
	`  void const * const request,`
	`  uint32_t const request_size,`
	`  uint32_t timeout,`
	`  int8_t const priority);`

C++	`int CloudI::API::mcast_async(STRING name,`
	`  void const * const request_info,`
	`  uint32_t const request_info_size,`
	`  void const * const request,`
	`  uint32_t const request_size,`
	`  uint32_t timeout,`
	`  int8_t const priority) const;`

Java	`List<TransId> org.cloudi.API.mcast_async(String name, byte[] r`
	`  byte[] request, Integ`
	`  Byte priority);`

Python	`cloudi_c.API.mcast_async(name, request,`
	`  timeout=None, request_info=None, pri`
	`cloudi.API.mcast_async(name, request,`
	`  timeout=None, request_info=None, prior`

Ruby	`CloudI::API.mcast_async(name, request,` `  timeout=nil, request_info=nil, priorit`

Multicast asynchronously, which is the same as publish, except that it is possible to respond to the service request. The function mcast_async will send the service request asynchronously to all services that have subscribed to a service name pattern that matches the service name destination. The mcast_async function will block until at least a single request has been sent or the timeout has expired. The result of the function call is a list of TransIds (one TransId per service request). If a publish request is required, the destination service should have a null response (an empty binary of size 0), so that the service request response is ignored.

Function Return Values:

Programming Language	Return Value
Erlang	`{'ok', TransIdList :: list(<<_:128>>)}` `{'error', Reason :: atom()}`

C	Separate functions are provided to get the function result after a successful send_async function call (an integer 0 return value).
	`cloudi_get_trans_id_count(p)`
	`cloudi_get_trans_id(p, i)`

C++	Separate functions are provided to get the function result after a successful send_async function call (an integer 0 return value).
	`uint32_t CloudI::API::get_trans_id_count() const;`
	`char const * CloudI::API::get_trans_id(unsigned int const i =`

Java	A class encapsulates the function result. `List<org.cloudi.API.TransId>`

Python	The trans_id is a string of 16 bytes. `[trans_id]`
Ruby	The trans_id is a string of 16 bytes. `[trans_id]`

The mcast_async result is provided in ways typical to each programming language, as shown above. A TransId is a v1 UUID.

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1.10 - mcast_async_active (Erlang-only)

Programming Language	Function Call

Erlang	`cloudi_service:mcast_async_active(Dispatcher :: pid(),`
	`Name :: string(),`
	`RequestInfo :: any(),`
	`Request :: any(),`
	`Timeout :: non_neg_integer()`
	`'undefined' | 'in`
	`Priority :: integer() | 'und`
	`{'ok', TransIdList :: list(<<_:128>>)} |`
	`{'error', Reason :: atom()}.`

The mcast_async_active function provides the same functionality as the mcast_async function within an Erlang process, but the response is automatically sent to the Erlang process, after completion. Using mcast_async_active is the preferred way to publish an asynchronous service request in Erlang because it utilizes Erlang's concurrency without requiring a blocking operation (a passive send, using Erlang vernacular, since it would otherwise require a call of the function recv_async to receive the request). The mcast_async_active function is not implemented in other languages because of their lack of a native Actor Model.

Incoming Process Message (the same as the send_async_active messages):

Programming Language	Messages

Erlang	`{'return_async_active', Name :: string(), Pattern :: string(),`
	`  ResponseInfo :: any(), Response :: any(),`
	`  Timeout :: non_neg_integer(), TransId :: <<_:128>>}`
	`{'timeout_async_active', TransId :: <<_:128>>}`

The mcast_async_active message is sent to the Erlang process as an Erlang message, so it arrives in the cloudi_service_handle_info function of the Erlang service module (i.e., the module that implements the cloudi_service behavior). The message formats are also provided as records that are accessible with:

```
-include_lib("cloudi_core/include/cloudi_service.hrl").
```

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1.11 - recv_async

Programming Language	Function Call
Erlang	`cloudi_service:recv_async(Dispatcher :: pid(),` `  Timeout :: non_neg_integer() |` ` 'undefined'	'immediate` ` TransId :: <<_:128>>,` ` Consume :: boolean()) ->` ` {'ok', ResponseInfo :: any(), Response :: any(),` ` TransId :: <<_:128>>} |` ` {'error', Reason :: atom()}.`

C	`int cloudi_recv_async(cloudi_instance_t * p,`
	`  uint32_t timeout,`
	`  char const * const trans_id,`
	`  int consume);`

C++	`int CloudI::API::recv_async(uint32_t timeout,`
	`  STRING trans_id,`
	`  bool consume) const;`

Java	`Response org.cloudi.API.recv_async(Integer timeout, byte[] tra` `  boolean consume);`
Python	`cloudi_c.API.recv_async(timeout=None, trans_id=None, consume=T` `cloudi.API.recv_async(timeout=None, trans_id=None, consume=Tru`

Receive an asynchronous service request's response. If a TransId is not provided, a null UUID is used to request the oldest response that has not timed out. By default, the recv_async function will consume the service request so it is not accessible with the same function call in the future. The TransId of the service request is always returned for any external use or tracking of the request or response.

Function Return Values:

Programming Language	Return Value

Erlang	ResponseInfo and Response are only returned if both do not not e <<>>.
	`{'ok', ResponseInfo :: any(), Response :: any(),`
	`TransId :: <<_:128>>}`
	`{'error', Reason :: atom()}`

C	Separate functions are provided to get the function result after a successful recv_async function call (an integer 0 return value).
	`cloudi_get_response(p)`
	`cloudi_get_response_size(p)`
	`cloudi_get_response_info(p)`
	`cloudi_get_response_info_size(p)`
	`cloudi_get_trans_id_count(p)`
	`cloudi_get_trans_id(p, i)`

C++	Separate functions are provided to get the function result after a successful recv_async function call (an integer 0 return value).
	`char const * CloudI::API::get_response() const;`
	`uint32_t CloudI::API::get_response_size() const;`
	`char const * CloudI::API::get_response_info() const;`
	`uint32_t CloudI::API::get_response_info_size() const;`
	`uint32_t CloudI::API::get_trans_id_count() const;`
	`char const * CloudI::API::get_trans_id(unsigned int const i =`

Java	A class encapsulates the function result. `org.cloudi.API.Response`
Python	A tuple provides the function result.

```
(response_info, response, trans_id)
```

An array provides the function result.

Ruby

```
[response_info, response, trans_id]
```

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1.12 - recv_asyncs (Erlang-only)

Programming Language	Function Call

Erlang

```
cloudi_service:recv_asyncs(Dispatcher :: pid(),
                           Timeout :: non_neg_integer() |
                                      'undefined' | 'immediat
                           TransIdList :: list(<<_:128>>),
                           Consume :: boolean()) ->
    {'ok', list({ResponseInfo :: any(), Response :: any(),
                 TransId :: <<_:128>>})} |
    {'error', Reason :: atom()}.
```

Internal (Erlang-only) services can block to receive multiple asynchronous service request responses. By default, the recv_asyncs function will consume the service request so it is not accessible with the same function call in the future. The TransId of the service request is always returned for any external use or tracking of the request or response. The recv_asyncs function is not implemented in other languages to avoid unbounded memory consumption and caching/heap allocation impossibilities.

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1.13 - return

Programming Language	Function Call

Erlang

```
cloudi_service:return(Dispatcher :: pid(),
                      Type :: 'send_async' | 'send_sync',
                      Name :: string(),
                      Pattern :: string(),
                      ResponseInfo :: any(),
                      Response :: any(),
```

	`Timeout :: non_neg_integer(),`
	`TransId :: <<_:128>>,`
	`Pid :: pid()) ->`
	`none().`

C	`int cloudi_return(cloudi_instance_t * p,`
	`int const command,`
	`char const * const name,`
	`char const * const pattern,`
	`void const * const response_info,`
	`uint32_t const response_info_size,`
	`void const * const response,`
	`uint32_t const response_size,`
	`uint32_t timeout,`
	`char const * const trans_id,`
	`char const * const pid,`
	`uint32_t const pid_size);`

C++	`int CloudI::API::return_(int const command,`
	`STRING name,`
	`STRING pattern,`
	`void const * const response_info,`
	`uint32_t const response_info_size,`
	`void const * const response,`
	`uint32_t const response_size,`
	`uint32_t timeout,`
	`char const * const trans_id,`
	`char const * const pid,`
	`uint32_t const pid_size) const;`

Java	`void org.cloudi.API.return_(Integer command,`
	`String name, String pattern,`
	`byte[] response_info, byte[] respo`
	`Integer timeout, byte[] transId,`
	`OtpErlangPid pid);`

Python	`cloudi_c.API.return_(command, name, pattern, response_info, re`
	`timeout, trans_id, pid)`
	`cloudi.API.return_(command, name, pattern, response_info, resp`
	`timeout, trans_id, pid)`

Ruby	`CloudI::API.return_(command, name, pattern, response_info, res` `timeout, trans_id, pid)`

Return a response to a service request. The return function will throw a

caught exception so that the request handler execution is aborted after returning the service request response. The simplest and preferred way to return a response within an Erlang service is to utilize the cloudi_service_handle_request functon return values used by the cloudi_service behavior. You can also utilize the request handler return value for the response in the programming languages Java, Python, and Ruby. However, within the external services it is more explicit (i.e., easier to understand the source code) when the source code uses the return functions.

If the service is configured with the request_timeout_adjustment option set to true (the default is false), the request handler execution time will automatically decrement the request timeout, after the request has been handled. If the service is configured with the response_timeout_adjustment option set to true (the default is false), the response timeout is automatically decremented based on the sender-side's timing (more accurate).

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1.14 - forward

Programming Language	Function Call

Erlang	`cloudi_service:forward(Dispatcher :: pid(),`
	`  Type :: 'send_async' | 'send_sync',`
	`  Name :: string(),`
	`  RequestInfo :: any(),`
	`  Request :: any(),`
	`  Timeout :: non_neg_integer(),`
	`  Priority :: integer(),`
	`  TransId :: <<_:128>>,`
	`  Pid :: pid()) ->`
	`  none().`

C	`int cloudi_forward(cloudi_instance_t * p,`
	`  int const command,`
	`  char const * const name,`
	`  void const * const request_info,`
	`  uint32_t const request_info_size,`
	`  void const * const request,`
	`  uint32_t const request_size,`
	`  uint32_t timeout,`
	`  int8_t const priority,`
	`  char const * const trans_id,`
	`  char const * const pid,`
	`  uint32_t const pid_size);`

Forward the service request to a different destination, possibly with different parameters (e.g., a completely different request). The forward function will throw a caught exception so that the request handler execution is aborted after forwarding the service request. The simplest and preferred way to forward a request within an Erlang service is to utilize the cloudi_service_handle_request functon return values used by the cloudi_service behavior. All external services must use a forward function when forwarding a request.

If the service is configured with the request_timeout_adjustment option set to true (the default is false), the request handler execution time will automatically decrement the request timeout, after the request has been handled. If the service is configured with the response_timeout_adjustment option set to true (the default is false), the response timeout is automatically decremented based on the sender-side's timing (more accurate).

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CloudI Service API - Controlling CloudI

2.0 - Introduction

When CloudI is first started, the configuration file at /usr/local/etc/cloudi/cloudi.conf is used to determine what Access Control Lists (ACLs) should be used for services, what services should be started, what nodes should be connected, and what logging should occur. All the configuration functionality for CloudI can be done dynamically, after startup, with the CloudI Service API. A typical way to use the Service API is with either erlang terms or JSON-RPC over HTTP (using cloudi_service_api_requests and cloudi_service_http_cowboy). The CloudI Service API can also be accessed directly within the Erlang VM by using the cloudi_service_api module.

Protocol	Example
Erlang	`curl http://localhost:6467/cloudi/api/erlang/services`
JSON-RPC	`curl -X POST -d '{"method": "services", "params":[], "id": 1}' http://localhost:6467/cloudi/api/json_rpc/`

The data returned in both examples is Erlang terms within a string. All of the examples below use the Erlang protocol.

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2.1 - acl_add

```
curl -X POST -d '[{sensitive, ["/accouting/", "/finance/"]}]'
     http://localhost:6467/cloudi/api/erlang/acl_add
```

Add more ACL entries to be later used when starting services. An ACL entry is an Erlang atom() -> list(atom() | string()) relationship which provides a logical grouping of service name patterns (e.g., {api, ["/cloudi/api/"]}). When providing a service name pattern for an ACL entry, a non-pattern will be assumed to be a prefix (i.e., "/cloudi/api/" == "/cloudi/api/*").

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2.2 - acl_remove

```
curl -X POST -d '[sensitive]' http://localhost:6467/cloudi
     /api/erlang/acl_remove
```

Remove ACL entries that are no longer needed. Running services will retain their configuration, so this impacts services that are started in the future.

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2.3 - service_subscriptions

```
curl -X POST -d
     '<<106,103,84,112,122,31,17,226,212,14,165,221,0,0,0,88>>'
     http://localhost:6467/cloudi/api/erlang
     /service_subscriptions
```

List the subscriptions a service instance has initiated.

2.4 - services_add

```
curl -X POST -d '[{external, "/tests/flood/", "tests/flood
     /service/flood", "", [{"LD_LIBRARY_PATH", "api/c/lib/"},
     {"DYLD_LIBRARY_PATH", "api/c/lib/"}], none, default,
     default, 5000, 5000, 5000, [api], undefined, 1, 1, 5, 300,
```

```
      []}, {internal, "/tests/flood/", cloudi_service_flood,
      [{flood, "/tests/flood/c", <<"DATA">>, 1000}],
      lazy_closest, 5000, 5000, 5000, [api], undefined, 2, 5,
      300, []}]' http://localhost:6467/cloudi/api/erlang
      /services_add
```

Start services and return their Service UUIDs. Provide service configuration using the same syntax found in the configuration file (i.e., /usr/local/etc/cloudi/cloudi.conf). Internal services will need to be located in a code path that the running Erlang VM is aware of (see code_path_add). The syntax of the configuration entries is shown below:

```
% proplist format with cloudi_service_api types
[{type, internal | external},                % inferred from module or file_pa
 {prefix, cloudi:service_name_pattern()},    % default is "/"
 {module, atom() | file:filename()},         % internal service only
 {file_path, file:filename()},               % external service only
 {args, list()},                             % default is []
 {env, list({string(), string()})},          % default is []
 {dest_refresh, dest_refresh()},             % default is immediate_closest
 {protocol, default | local | tcp | udp},    % default is local
 {buffer_size, default | pos_integer()},     % default is 16384
 {timeout_init, timeout_milliseconds()},     % default is 5000
 {timeout_async, timeout_milliseconds()},    % default is 5000
 {timeout_sync, timeout_milliseconds()},     % default is 5000
 {dest_list_deny, dest_list()},              % default is undefined
 {dest_list_allow, dest_list()},             % default is undefined
 {count_process, pos_integer() | float()},   % default is 1
 {count_thread, pos_integer() | float()},    % default is 1
 {max_r, non_neg_integer()},                 % default is 5
 {max_t, seconds()},                         % default is 300
 {options, service_options_internal() |      % default is []
           service_options_external()}]

% internal service tuple format
{internal,
 (ServiceNamePrefix),
 (ErlangModuleName),
 (ModuleInitializationList),
 (DestinationRefreshMethod),
 (InitializationTimeout in milliseconds),
 (DefaultAsynchronousTimeout in milliseconds),
 (DefaultSynchronousTimeout in milliseconds),
 (DestinationDenyACL),
 (DestinationAllowACL),
 (ProcessCount),
 (MaxR),
 (MaxT in seconds),
```

```
  (ServiceOptionsPropList)}

% external service tuple format
{external,
 (ServiceNamePrefix),
 (ExecutableFilePath),
 (ExecutableCommandLineArguments),
 (ExecutableEnvironmentalVariables),
 (DestinationRefreshMethod),
 (Protocol, use 'default'),
 (ProtocolBufferSize, use 'default'),
 (InitializationTimeout in milliseconds),
 (DefaultAsynchronousTimeout in milliseconds),
 (DefaultSynchronousTimeout in milliseconds),
 (DestinationDenyACL),
 (DestinationAllowACL),
 (ProcessCount),
 (ThreadCount),
 (MaxR),
 (MaxT in seconds),
 (ServiceOptionsPropList)}
```

The ACL lists contain either atoms that reference the current ACL configuration or strings. If an ACL string is not a pattern, it is assumed to be a prefix (i.e., "*" is appended to make it a pattern). The ProcessCount and ThreadCount can be specified as integers for an exact count or as a floating point number to provide a CPU multiplier (X < 1.0 is round, X > 1.0 is floor). MaxR is the maximum restarts allowed within MaxT seconds (same parameters used by Erlang supervisors). The ServiceOptionsPropList provides the configurable defaults:

Option	Default	Details
priority_default	0	-128(high) ≤ priority ≤ 127(low)
queue_limit	undefined	A limit on the total number of incoming service requests that are queued while the service is busy (limits memory consumption)
dest_refresh_start	500	Delay after startup (in milliseconds) before requesting the initial service group membership (when

		using a lazy destination refresh method)
dest_refresh_delay	300000	Maximum possible time (in milliseconds) for a service death to remove service group membership (when using a lazy destination refresh method)
request_timeout_adjustment	false	Should the service request handler execution time decrement the request timeout, after the request has been handled.
request_timeout_immediate_max	20000	Maximum timeout (in milliseconds) considered "immediate". Larger timeouts monitor the service request destination to avoid timer memory consumption when a destination dies.
response_timeout_adjustment	false	Should the service's incoming response timeout be automatically decremented based on the sender-side's timing (more accurate).
response_timeout_immediate_max	20000	Maximum timeout (in milliseconds) considered "immediate". Larger timeouts will send a null response instead of discarding a null response (a null response is when both the ResponseInfo and Response parameters are <<>>).
count_process_dynamic	false	Dynamically adjust the number of processes used within the service instance

		based on the service request rate that occurs. When set to a list ([]) options can be provided.
scope	default	The scope (an Erlang atom) is the scope which is used for all service name lookups and subscriptions. If you use a unique scope, you can isolate your service and reduce contention when using an immediate destination refresh method.
monkey_latency	false	Add latency to all service requests and info messages for systems testing. If set to 'system', use the settings within the cloudi_core Erlang application configuration. When set to a list ([]) options can be provided.
monkey_chaos	false	Add instability to the service for testing systems fault-tolerance. If set to 'system', use the settings within the cloudi_core Erlang application configuration. When set to a list ([]) options can be provided.
duo_mode	false	(internal services only) Use two Erlang processes instead of one Erlang process, so that more incoming service throughput can be handled with low latency.
hibernate	false	(internal services only) Always make the service

		Erlang processes hibernate to conserve memory by using more frequent garbage collections, if set to true. When set to a list ([]) options can be provided.
reload	false	(internal services only) Automatically reload the service module or any of the modules within a service application when the module's beam file is updated on the filesystem.
application_name	undefined	(internal services only) Use a different name when loading an Erlang application and its dependencies for this internal service.
automatic_loading	true	(internal services only) Should the internal service and its dependencies be loaded automatically? This includes the associated Erlang application, the Erlang application dependencies, module loading, and module compilation if necessary.
request_pid_uses	1	(internal services only) How many service requests to handle before utilizing a new Erlang process for a new incoming service request.
request_pid_options	[]	(internal services only) erlang:spawn_opt/2 options to control memory usage of the service request handling Erlang process

		(fullsweep_after, min_heap_size, min_bin_vheap_size).
info_pid_uses	infinity	(internal services only) How many info messages to handle before utilizing a new Erlang process for a new incoming info message. This Erlang process is the second process that is utilized when duo_mode is true (duo_mode requires that this is set to infinity).
info_pid_options	[]	(internal services only) erlang:spawn_opt/2 options to control memory usage of the info message handling Erlang process (fullsweep_after, min_heap_size, min_bin_vheap_size).

count_process_dynamic:

Option	Default	Details
period	5	Time period (in seconds) for determining the current rate of service requests.
rate_request_max	1000	Maximum requests per second. If the current rate of service requests exceeds this limit the process count is increased as much as is required to keep the current rate of service requests under the maximum.
rate_request_min	100	Minimum requests per second. If the current rate of service requests is lower than this limit the process count is decreased as much as is required to keep the current rate of service requests above the minimum.

count_max	4.0	The maximum process count value that can be used for this service. An integer provides an absolute number while a floating point number is used as a CPU multiplier (in the same way as ProcessCount).
count_min	0.5	The minimum process count value that can be used for this service. An integer provides an absolute number while a floating point number is used as a CPU multiplier (in the same way as ProcessCount).

monkey_latency:

Option	Details
time_uniform_min	Minimum amount of latency (in milliseconds) to be applied from a uniform distribution of random values.
time_uniform_max	Maximum amount of latency (in milliseconds) to be applied from a uniform distribution of random values.
time_gaussian_mean	Average amount of latency (in milliseconds) to be applied from a gaussian distribution of random values.
time_gaussian_stddev	Standard deviation of the gaussian distribution used for random latency values.
time_absolute	Use a single value (in milliseconds) for the amount of latency.

monkey_chaos:

Option	Details
probability_request	The probability a service request or info message will terminate a service process.
probability_day	The probability that a service process will be terminated at a random point during the day.

hibernate:

Option	Default	Details
period	5	Time period (in seconds) for determining the current rate of service requests.
rate_request_min	1	Minimum requests per second. If the current rate of service requests is lower than this limit the service will hibernate.

Please see the configuration file /usr/local/etc/cloudi/cloudi.conf for more specific examples.

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2.5 - services_remove

```
curl -X POST -d
     '[<<110,129,240,166,122,31,17,226,212,14,165,221,0,0,0,88>>,
     <<110,129,240,236,122,31,17,226,212,14,165,221,0,0,0,88>>]'
     http://localhost:6467/cloudi/api/erlang/services_remove
```

Provide the Service UUIDs for the services that should be stopped. The Service UUID is shown in the output of services. When the service is stopped, its running instance is removed from CloudI, but does not impact any other running instances (even if they are the same service module or binary).

When an internal service is removed and it is the last instance of the service module, the service module is purged to avoid later module conflicts. All instances of the internal service module should be configured in the same way (either a single module, an application, or a release with an application), so that the last instance is removed completely. If an application was used that is named the same as the service module, the application and its dependencies are removed (applications are stopped, modules are purged, and applications are unloaded) if the dependencies are not utilized by other applications. The same occurs if a release was used to start an application that contains the service module (the single top-level application of the release is used to determine dependencies, where the single top-level application within the release is the application that includes the service module).

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2.6 - services_restart

```
curl -X POST -d
     '[<<106,103,84,112,122,31,17,226,212,14,165,221,0,0,0,88>>]'
     http://localhost:6467/cloudi/api/erlang/services_restart
```

Provide the Service UUIDs for the services that should be restarted. The Service UUID is shown in the output of services. When the service is restarted, the old instance is stopped and a new instance is started. During the restart delay, it is possible to lose queued service requests and received asynchronous responses. Keeping the state separate between the service instances is important to prevent failures within the new instance.

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2.7 - services_search

```
curl -X POST -d '"/tests/http/text/post"' http://localhost:6467
     /cloudi/api/erlang/services_search
```

List the service configuration parameters with each service's UUID that are receiving service requests for a given service name.

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2.8 - services

```
curl http://localhost:6467/cloudi/api/erlang/services
```

List the service configuration parameters with each service's UUID.

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2.9 - nodes_add

```
curl -X POST -d "['cloud001@cluster1']" http://localhost:6467
     /cloudi/api/erlang/nodes_add
```

Explicitly add a CloudI node name, so that services between all other CloudI nodes and the added nodes can send each other service requests.

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2.10 - nodes_remove

```
curl -X POST -d "['cloud001@cluster1']" http://localhost:6467
     /cloudi/api/erlang/nodes_remove
```

Explicitly remove a CloudI node name.

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2.11 - nodes_alive

```
curl http://localhost:6467/cloudi/api/erlang/nodes_alive
```

List all the CloudI nodes known to be connected.

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2.12 - nodes_dead

```
curl http://localhost:6467/cloudi/api/erlang/nodes_dead
```

List all the CloudI nodes that are disconnected but expected to reconnect.

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2.13 - nodes

```
curl http://localhost:6467/cloudi/api/erlang/nodes
```

List both the connected and disconnected CloudI nodes.

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2.14 - loglevel_set

```
curl -X POST -d 'warn' http://localhost:6467/cloudi/api/erlang
     /loglevel_set
```

Modify the loglevel. CloudI uses asynchronous logging with flow control (backpressure handling) to prevent misbehaving services from causing instability.

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2.15 - log_redirect

```
curl -X POST -d 'cloudi@host' http://localhost:6467/cloudi
     /api/erlang/log_redirect
```

Redirect all local log output to a remote CloudI node. Use 'undefined' as the node name to log locally.

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2.16 - code_path_add

```
curl -X POST -d '"/home/user/code/services"'
     http://localhost:6467/cloudi/api/erlang/code_path_add
```

Add a directory to the CloudI Erlang VM code server's search paths. The path is always appended to the list of search paths (you should not need to rely on search path order because of unique naming).

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2.17 - code_path_remove

```
curl -X POST -d '"/home/user/code/services"'
     http://localhost:6467/cloudi/api/erlang/code_path_remove
```

Remove a directory from the CloudI Erlang VM code server's search paths. This doesn't impact any running services, only services that will be started in the future.

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2.18 - code_path

```
curl http://localhost:6467/cloudi/api/erlang/code_path
```

List all the CloudI Erlang VM code server search paths (in the same order the directories are searched).

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