The tour

- What, why and *how* of the daemon
- Architecture of the daemon

What

The daemon is a system service that creates tunnels.

- Runs as a standalone service on Windows, Linux, macOS and *kind of* Android
- Has a GRPC interface and a custom JNI interface for Android

Why

- Can have multiplicity of clients
- Better separation of concerns
- Need elevated privileges to do VPN things (routing, firewall)

Responsibilities

- Manage tunnel state - connected, disconnected, *blocking traffic* when necessary
- Be responsive to all front-ends, all the time
- Once the target state is set to be secured, must ensure there are no leaks
- Interface with our web service (relay list, version information, account validity)
- Manage user settings
- Keep track of account data and keys, the data necessary to connect

Concurrency and components

No one client must be able to block the daemon from servicing other clients.

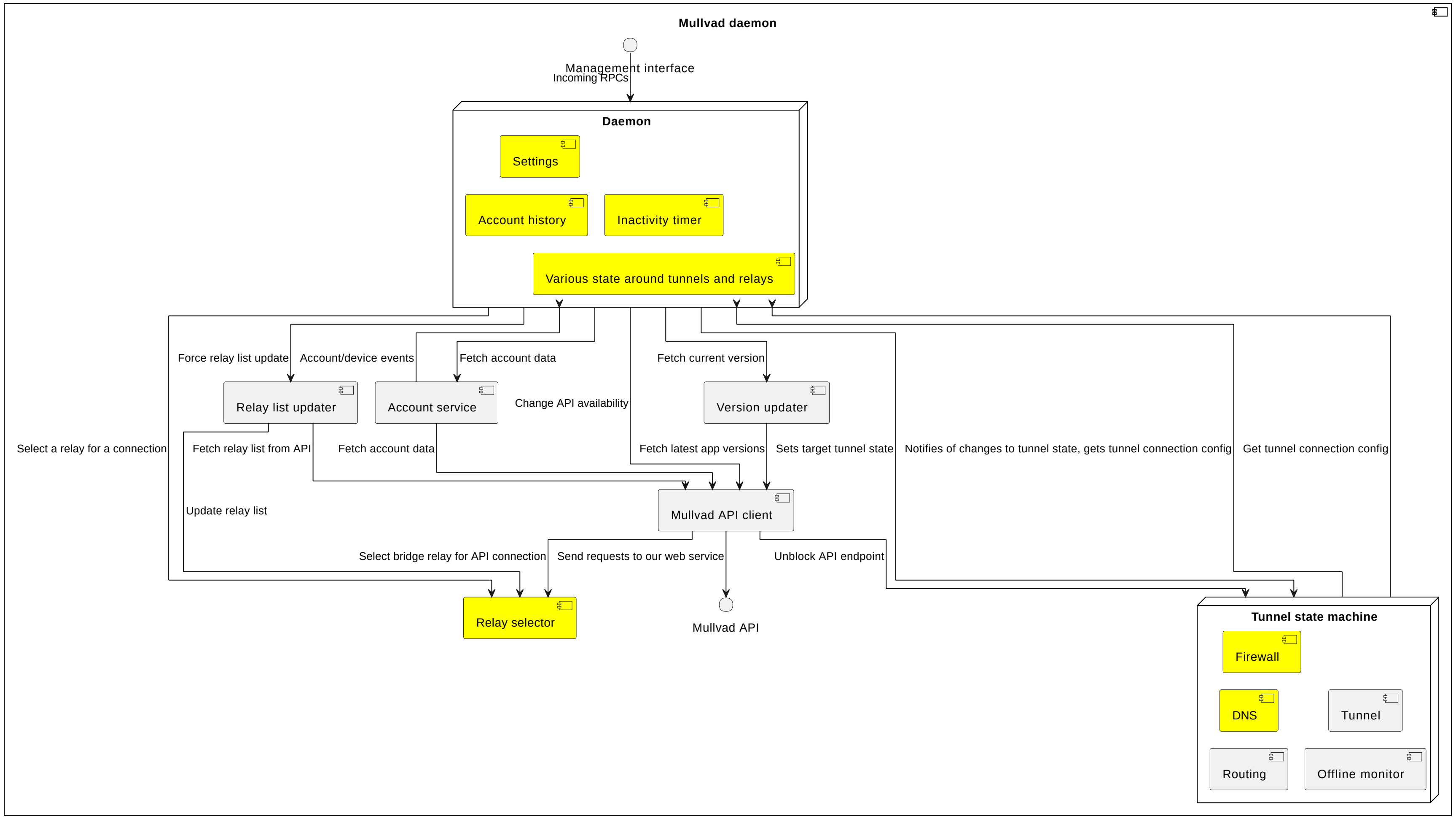
Lots of resources are being managed concurrently, e.g. downloading relay lists and monitoring routes.

The cast

The daemon has an actor system that's rather informal, so it consists of a lot of actors.

Each actor may contain loosely defined components, e.g. the tunnel state machine has a firewall component.

Whenever an RPC is called, an event corresponding to the RPC is sent to a daemon actor, and the daemon then processes the RPC.


Mullvad daemon
Management interface
Incoming RPCs
Daemon
Settings
Account history
Inactivity timer
Various state around tunnels and relays
Force relay list update
Account/device events
Fetch account data
Fetch current version
Relay list updater
Account service
Change API availability
Version updater
Select a relay for a connection
Fetch relay list from API
Fetch account data
Fetch latest app versions
Sets target tunnel state
Notifies of changes to tunnel state, gets tunnel connection config
Get tunnel connection config
Mullvad API client
Update relay list
Select bridge relay for API connection
Send requests to our web service
Unblock API endpoint
Relay selector
Mullvad API
Tunnel state machine
Firewall
DNS
Tunnel
Routing
Offline monitor

The supporting cast

There's lots of somewhat disparate components strewn across various crates and modules.

Common data types that would be used in different crates should be defined in either `mullvad-types` or `talpid-types` crates. These crates should contain as little logic as possible.

The great divide

Originally, the world was split into two - *talpid* and *mullvad*.

The talpid set of packages were supposed to be generic, and not Mullvad related.

As the codebase has developed, upholding this divide has only become more cumbersome with time.

Generally, one only needs `talpid-core` to have an application that creates safe tunnels safely.

To create a good VPN client that integrates with Mullvad, you'll want `mullvad-daemon`.

Talpid responsibilities

- Create tunnel interfaces
- Route traffic
- Set up firewall rules
- Enable split tunnelling

The daemon

The daemon has a whole crate of it's own, `mullvad-daemon`.

It effectively implements the management interface, servicing all RPCs and is the *entry point* of the process.

It's the most spaghetti component there is.

Interacts with

- TSM
- REST service
- Account manager
- Version checker
- Relay list updater
- Relay selector

Owns

- Setti

security properties of the client. The state machine has 5 distinct states:

- Disconnected
- Disconnecting
- Connecting
- Connected
- Error state

Interacts with

- Daemon
- REST service

Owns

- Firewall
- Route manager
- DNS manager

The tunnel state machine

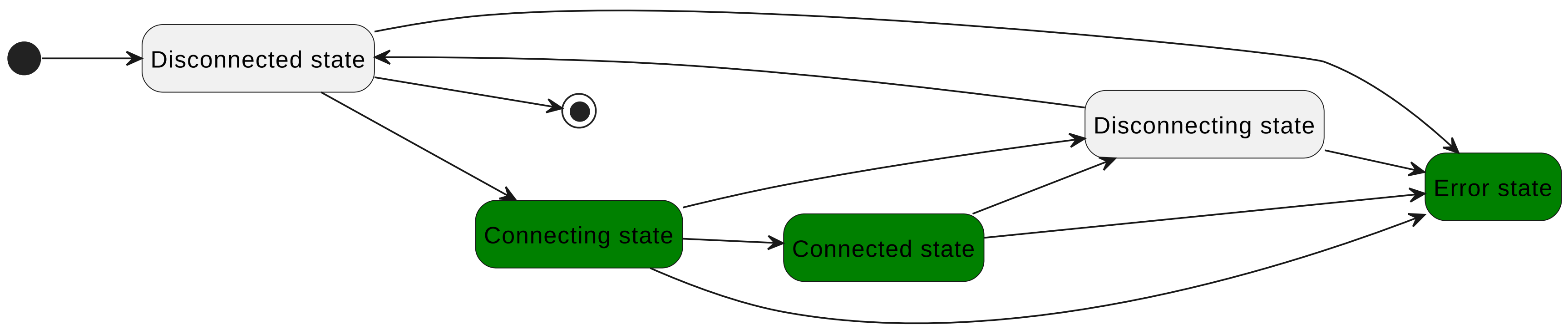
Everything except for the tunnel has a platform specific implementation, sometimes having multiple different implementations on the same platform (DNS on Linux).

Most of the platform specific code is Rust, and often depends on external crates, but Windows and Android are different.

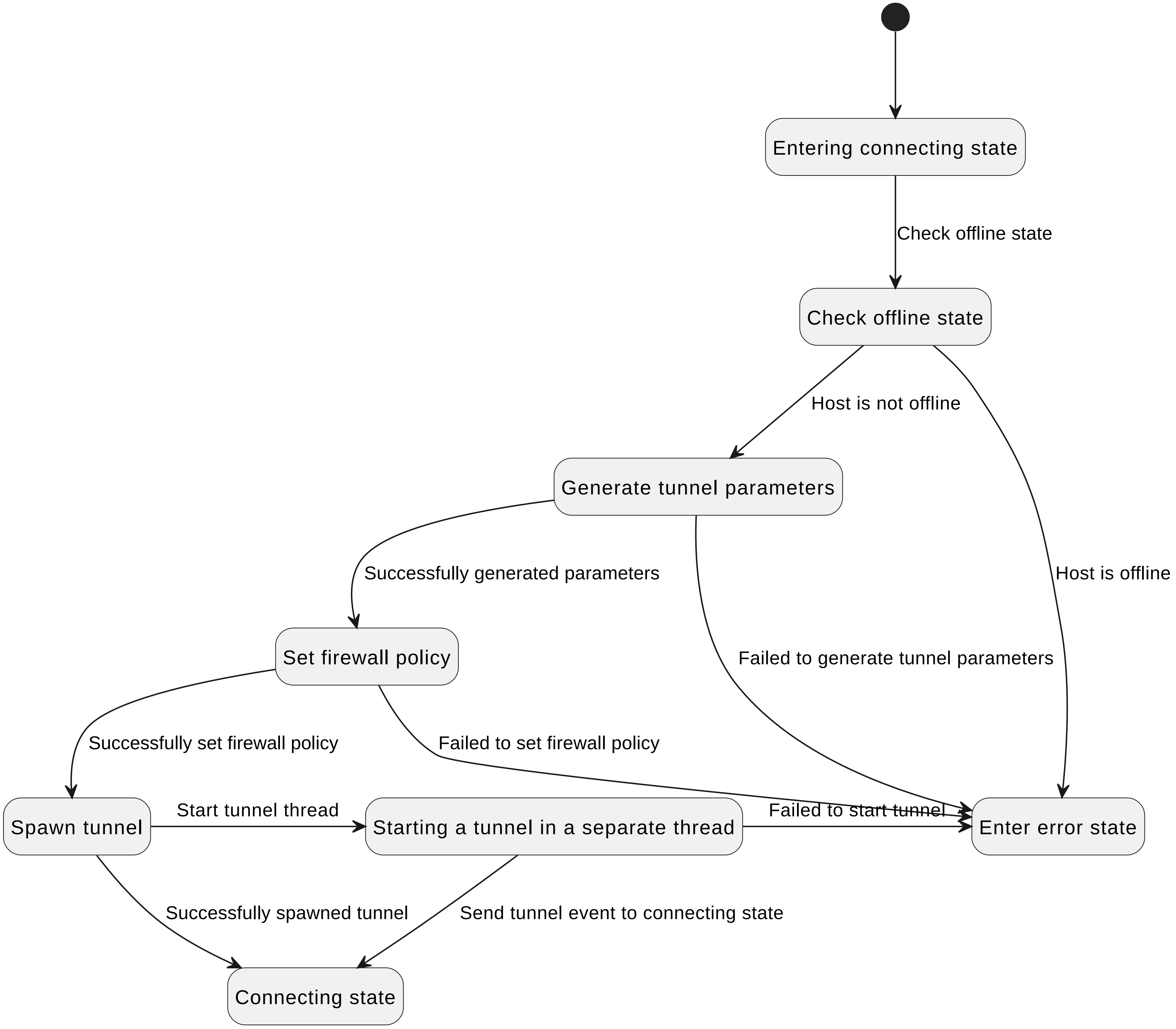
Windows has it's own implementations written in C++, resides in `windows/`.

Android implementations need to call into Java code, more on that later.

Various tunnel state transitions



Green states imply that firewall rules are active.


Entering connecting state
Check offline state
Check offline state
Host is not offline
Host is offline
Generate tunnel parameters
Successfully generated parameters
Failed to generate tunnel parameters
Set firewall policy
Successfully set firewall policy
Failed to set firewall policy
Spawn tunnel
Start tunnel thread
Starting a tunnel in a separate thread
Failed to start tunnel
Enter error state
Successfully spawned tunnel
Send tunnel event to connecting state
Connecting state

and allow connecting through a proxy.

It can:

- Send requests to our API
- Select an API endpoint
- Unblock said API endpoint in the firewall
- Drop all existing requests when a connection is reset
- Ensure that the API is reachable even in a blocked state //: # (DO mention that requests can be throttled)

Interacts with

- Daemon
- TSM
- Account service
- Device service

- Version checker

Account manager/service

- Checks if the account has expired
- After enough disconnects the daemon will make it check if the device is still valid
- Periodically rotates WireGuard key

Interacts with

- Daemon
- REST service

Owns

- Device data
- Doesn't own account expiry

A module of the `mullvad-daemon` crate.

Version updater

- Periodically checks if a newer version has been released
- Caches it's results

Interacts with

- Daemon
- REST service

Owns

- Cached version information

Resides in `mullvad_daemon::version_check`

Relay list updater

Periodically tries to download a newer version of the relay list.

Can also be forced into updating manually.

Interacts with

- Daemon
- REST service

Interface to the world

All user facing interactions with the daemon happen through the management interface.
//: # (Go look at the management interface proto file)

On Windows, Linux and macOS, it's a GRPC service listening on a unix socket/named pipe. See the `mullvad-management-interface` crate for more saucy details.

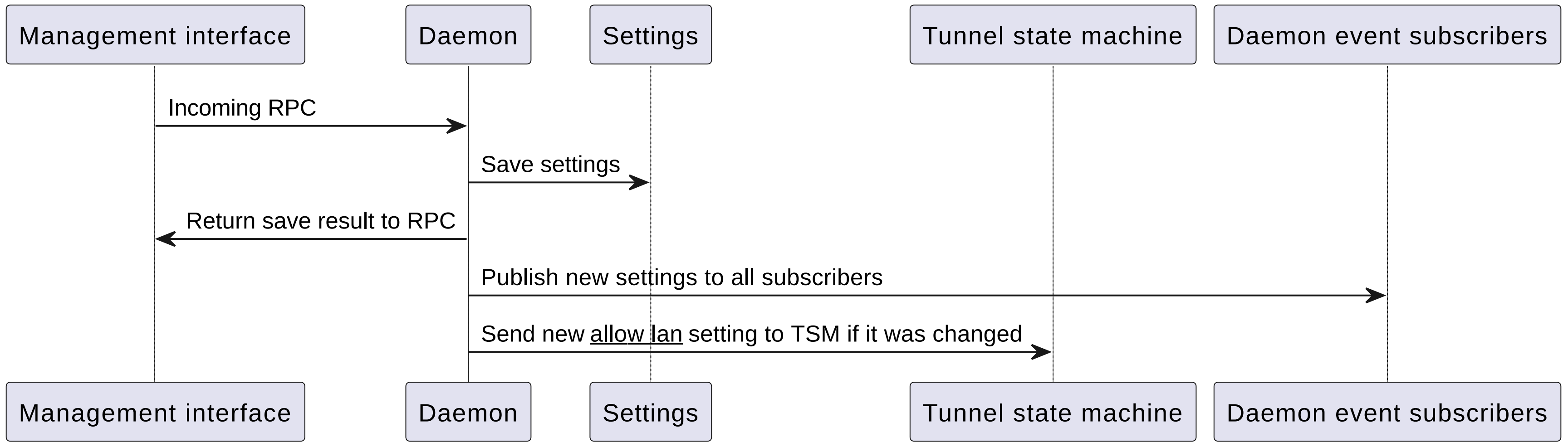
On Android, it's a custom JNI interface that generally mimics the GRPC interface.

RPCs

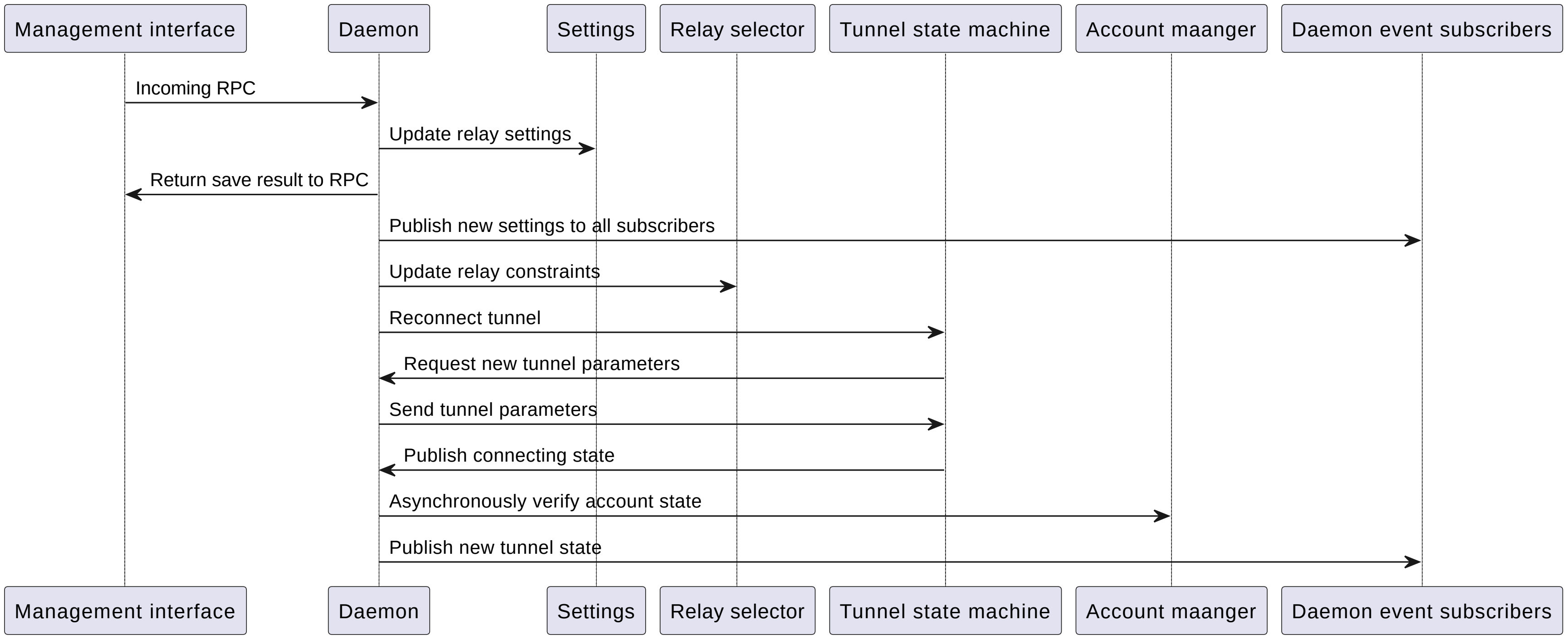
The various RPCs can be loosely grouped into the following groups:

- RPCs used to change target tunnel state
- Client version information
- Control the daemon's state (shutdown, prepare for a restart, factory reset).
- Setting relay constraints (changing settings that select relays)
- Changing settings
- Device management
- WireGuard key management
- Split tunelling (on Windows and Linux)

Execution of `set_allow_lan` RPC


Management interface
Daemon
Settings
Tunnel state machine
Daemon event subscribers
Incoming RPC
Save settings
Return save result to RPC
Publish new settings to all subscribers
Send new allow lan setting to TSM if it was changed

Execution of `update_relay_settings` RPC when relay settings have changed, but the key is invalid.



Events

The clients can also subscribe to a single stream of daemon events, which contain the following data:

- Changes in tunnel state
- Changes in settings
- Changes in account data

Android

Android's APIs are higher level and exposed through Java, so the JNI environment has to be dragged along to every call site.

The daemon doesn't (can't) handle routing.

There is no firewall per se, the tunnel and implied routes are used to block outgoing traffic.

For more info check out `mullvad-jni`

Startup

There are some interesting inter-dependencies before all of the components are set up.