Float Reference

Contents

Services

The fundamental concept in *float* is the **service**, a loose articulation of compute elements (containers, system-level daemons) and data, with standardized metadata properties that float uses to integrate it with its infrastructure.

A description of the service (its *specification*) is provided to float as part of its configuration. Float can manage an arbitrary number of services on a single infrastructure. The mapping between a "float service" and a "high-level, user-visible service" is quite often not one-to-one: float services are meant to describe the high-level service's *internal* architecture, which can be made up of multiple components.

In float, a service is also a *schedulable unit*: the service specification is in fact a template for specific service instances, of which there can be again more than one; consider for example the case of service replication for reliability / high-availability purposes. Float will never schedule more than one instance of a service on each host.

The decision to assign an instance of a service to a specific host is called *scheduling*, and it is completely controlled by float based on parameters of the service specification: it is possible to control the desired number of instances, and to restrict the choice of possible hosts by using host groups (leveraging the Ansible host group concept). The operator has no control on the specific assignments beyond that, and they may change at any time.

Float's scheduler is not particularly smart. It does not perform any kind of bin-packing (it only looks at instance counts), and, most importantly, it is *offline*-only: scheduling is only performed when Ansible runs, there is no online component to rebalance instances when they fail or to react to changes in load etc.

The float scheduler produces *stable* and *reproducible* results, which is very important given how it is meant to be used. The randomness used by the scheduling algorithm is seeded on the configuration itself, so two people running float on the same configuration on two different machines will obtain identical assignments.

Compute units

Compute units in float are long-running processes controlled via systemd. Float creates a systemd unit for every service instance on the hosts where it is supposed to run.

It is possible to specify more than one compute unit for the same service: in this case, they will all be scheduled together as part of the same service instance, and they will be reachable under the same service name (supposedly they will be using different network ports for communication).

Structuring services in terms of compute units

To show one possible approach to the subdivision of a service into fundamental compute units, we're going to show an example scenario and demonstrate the reasoning behind some possible choices, and how they relate to concepts in *float*.

Let's consider as an example a fairly typical two-layer service that uses Apache + PHP to serve a website, ignoring an eventual MySQL for now. This is a request-based service so some of the considerations that we're going to make will be specific to this perspective.

There are two major possibilities for representing such a service within float:

1. a float service "apache" and another float service "php", which may potentially be scheduled on different hosts, and that talk to each other over the service boundary: apache finds php endpoints using float's service discovery mechanism (i.e. DNS);
2. a single float service "web", with apache and php bundled together as a single unit of deployment, where apache talks to php inside the service

boundary (i.e. it connects to localhost). This scenario can be further split into two:

1. the float service "web" consists of an apache container and a separate php container, each runs independently of the other, they talk to each other either over the network (on localhost), or via an explicitly shared mechanism on the host (for instance a shared /run/web/sockets directory);
2. the float service "web" consists of a single container that bundles together apache and php, maybe here they talk to each other via a /run/web/sockets directory that is completely internal to the container itself.

Obviously the first problem to solve is that abstractions must make sense to you and to the specific problem you're solving. Here the "apache" and "php" components were pretty obvious choices for the two-layer service we were considering.

The second thing to consider in terms of *float* architecture is what we want the *request flow* to be: how, specifically, each component in our service stack is supposed to talk to the following one as the request flows downstream through the layers. Including float's reverse proxy layer in the picture, the conceptual flow is quite simple:

```
reverse proxy
    |
    V
  apache
    |
    V
   php
```

These components may be scheduled on different hosts (or not), so one thing to consider is what the latency at each step will be. Generally, as you move downwards the service stack, there is also a fan-out factor to consider: consider a PHP script making multiple MySQL requests, for instance.

The choice of representation depends on a number of different criteria and decisions, of which we'll name a few:

- A good question to consider is "what kind of actions do you want to take in order to scale your service"? Maybe you run a datacenter, servers are just bare compute capacity for you, and can just add new ones when apache or php look busy, independently, in which case you'd go towards scenario #1. Or perhaps your service is data-partitioned, and to add a new server means moving some of your data to it, in which case it would makes sense to co-locate apache and php with the data, which makes scenario #2 look more suitable.
- If your service is distributed among hosts in different locations, you might like scenario #2 more as it contains the latency to the reverse proxy ->

apache hop.

- For scenario #2, to decide amongst its two variants, another good question is "how do you like to build your containers"? This is a release engineering topic that depends on your CI, on what your upstreams look like, etc.

In terms of container bundling (#2.1 vs #2.2 above), we like our containers do to "one thing", for whatever definition of "thing" you find useful (provide a service, for example), so we run an init daemon inside our containers to differentiate between important processes, that control the lifecycle of the container itself, and non-important ones that can simply be restarted whenever they fail.

For instance, let's consider a hypothetical mailing list service: this has at least two major inbound APIs, a SMTP entry point for message submission, and an HTTP API for mailing list management. These are implemented by separate processes. We also want to run, say, a Prometheus exporter, yet another separate process: but we don't particularly care about its fate as long as it is running, and anyway monitoring will tell us if it's not running, so this process is "less important" than the first two. We would have these three processes in a single container, with the first two marked as "important" (i.e. the container will terminate when they exit, signaling a failure to float through systemd and monitoring), while the exporter would be marked as not-important and simply silently restarted whenever it fails.

Containers

The primary form of compute unit in float is a container. Float will automatically download the images and run the containers specified in the service description.

Though it is possible to run all kinds of container images, float is explicitly tuned towards a very particular kind of it:

- logs to standard output/error
- can run as an arbitrary (not known in advance) user ID, does not require to be run as internal uid 0
- can run from a read-only root filesystem image (except for the usual /tmp /run etc)
- can be configured via environment variables

Such containers will result in the least amount of additional configuration in the service description.

Float can use either docker or Podman for running containers, though on modern systems (Debian buster and up) it will choose Podman.

System-level daemons

Since float controls services by representing them as systemd units, it is also possible to create services that are made of system-level processes, i.e. "normal" systemd units.

This is convenient, for instance, when you are migrating an existing infrastructure to float, and you want to control the pace of containerization of your services: if you can describe your service in terms float understands, you can continue to configure it at the system level using Ansible and at the same time take advantage of float's infrastructural services.

Networking

Compute units in float share the host network namespace, network daemons are normally expected to bind to 0.0.0.0, while float manages the firewall to prevent unauthorized access.

Since the service mechanism discovery provides no way to do port resolution, all instances of a service are expected to use the same ports.

Float supports automatic provisioning of the firewall for TCP ports, in the following way:

- ports specified in a container description can be reached by other containers running on the same host, specifically other containers parts of the same service, as *localhost*;
- ports specified in the service description can be reached by other hosts (over the float infrastructure internal network overlay);
- ports that are part of the service's *public endpoints* can be reached by the float frontend reverse gateway hosts, over the internal network overlay;
- ports that are part of the service's *monitoring endpoints* can be reached by the hosts where the monitoring scrapers are running, over the internal network overlay.

In no case float will allow public access to a service. If this is desired, or if a service requires unsupported networking configuration (UDP, other protocols, etc.), it has to be achieved by adding the relevant firewall configuration snippet manually via the service's Ansible role.

Users and permissions

For isolation purposes, float will create a dedicated UNIX user and group for every service on the hosts where its instances run. For historical reasons, this user will be called `docker-`*servicename*. The containers will be run as this user, unless explicitly configured otherwise.

If you need to share data with the container, for instance by mounting data volumes, use this user (or group) for filesystem permissions.

If the service has any *service_credentials*, a dedicated UNIX group will be created for those named *credentials-name*`-credentials`, and the service user will be a member of it.

Data

Datasets allow you to describe data that is attached to a service: this information will be used to automatically configure the backup system. A dataset is either a local filesystem path, or something that can be dumped/loaded via a pipe. It is associated with every instance of the service, so it usually identifies local data. This assumes a partitioned service by default. But master-elected services can use the *on_master_only* option to make backups of global, replicated datasets only once (on the service master host).

Backups

If provided with credentials for an external data repository, float will automatically make backups of your configured datasets. Float runs its own backup management system (tabacco) on top of Restic, which adds additional metadata to Restic snapshots to map float datasets.

When a service is scheduled on a new host, for instance as a result of a rescheduling, float will attempt to restore the associated datasets from their backups. While this is not a practical failover solution for complex services, we've found it works pretty well for a category of services with "important, but small - can afford to lose one day of changes" datasets that is quite common and useful in itself. For these services, running with num_instances=1 and counting on the backup/restore data move mechanism might provide sufficient availability and reliability.

Restores can of course also be triggered manually whenever necessary.

Volumes

Volumes represent LVs that are associated with a service. They are managed by float, which makes sure that they are present on the hosts. Volumes aren't currently being ever removed, because we're scared of deleting data.

SSL Credentials

In the spirit of separation between internal and user-facing concerns, float offers both an internal X509 PKI for mutual service authentication, and an integration with ACME services such as Letsencrypt for user-facing SSL certificates.

Internal mTLS PKI

Service communication should be encrypted, and communicating services should authenticate each other. One of the ways to do this is with TLS as the transport layer. Float provides its own *service PKI* to automatically generate X509 credentials for all services.

The X509 certificates are deployed on the host filesystem, and access to them is controlled via UNIX permissions (using a dedicated group, which the service user is a member of). This provides an attestation of UNIX identity across the whole infrastructure.

Each service, in *services.yml*, can define multiple credentials, each with its own name and attributes: this can be useful for complex services with multiple processes, but in most cases there will be just a single credential, with the same name as the service. When multiple credentials are used, all server certificates will have the same DNS names (those associated with the service), so it's unusual to have multiple server credentials in a service specification.

Credentials are saved below `/etc/credentials/x509/<name>`, with the following structure:

```
/etc/credentials/x509/<name>/
  +-- ca.pem                    CA certificate for the service PKI
  +-- client/
  |   +-- cert.pem              Client certificate
  |   \-- private_key.pem       Client private key
  \-- server/
      +-- cert.pem              Server certificate
      \-- private_key.pem       Server private key
```

Private keys are stored unencrypted, and are only readable by the `<name>-credentials` group. The user that the service runs as must be a member of this group.

Server certificates will include all the names and IP addresses that service backends are reachable as. This includes:

- *service_name.domain*
- *service_name*
- *hostname.service_name.domain*
- *hostname.service_name*
- *shard.service_name.domain* (if present)
- *fqdn*
- localhost
- all public IP addresses of the host
- all IP addresses of the host on its network overlays

The purpose is to pass server name validation on the largest number of clients possible, without forcing a specific implementation.

Client certificates have the following names, note that it is using the credentials name, not the service name:

- *name.domain*
- *name*

Using multiple client credentials for a single service might allow ACL separation in complex services.

Most legacy services should be able to implement CA-based client certificate validation, which at least protects the transport from unprivileged observers. But some clients can validate the client certificate CN, which implements a form of distributed UNIX permission check (the client had access to a specific certificate), and is therefore preferable.

Public credentials

Float runs an ACME client to generate valid SSL certificates for public-facing HTTPS domains associated with a service.

Since these SSL certificates are relatively short-lived, the ACME mechanics run online on the target infrastructure: certificates are continuously renewed, not only when you run Ansible.

SSL certificates are normally only consumed by the *frontend* float service, where incoming traffic is SSL-terminated by the traffic routers; internal services run with certificates from the internal PKI for mutual authentication with the traffic routers. However this is only the case for HTTP-based services: float does not currently offer SSL termination for other protocols, in which case the SSL connections will be forwarded directly to the backend service, which then needs access to the public SSL certificates. A dedicated mechanism is provided so that a service can "request" a local copy of the certificates, and be reloaded when it is updated.

Configuration

Most services won't be configurable just with environment variables, and are going to require some sort of configuration file. Float has no facilities for specifying configuration file contents in the service description metadata itself: this responsibility is delegated to Ansible. An Ansible role, associated with the service, should be used to create the necessary configuration files and other required system-level setup for the service.

services.yml

```yaml
myservice:
  containers:
    - name: http
      image: myservice:stable
      volumes:
        - /etc/myservice.conf: /etc/myservice.conf
```

roles/myservice/tasks/main.yml

```yaml
- template:
    src: myservice.conf.j2
    dest: /etc/myservice.conf
```

```yaml
    group: docker-myservice
    mode: 0640
```

roles/myservice/templates/myservice.conf.j2

```
# Just an example of an Ansible template, with no particular meaning.
domain={{ domain }}
```

The Ansible role then needs to be explicitly associated to the hosts running the service instances via the Ansible playbook (unfortunately float can't automatically generate this association itself):

```yaml
- hosts: myservice
  roles:
    - myservice
```

This takes advantage of the fact that float defines an Ansible group for each service (with the same name as the service itself), which includes the hosts that the service instances have been scheduled on. **Note** that since Ansible 2.9, the group names will be "normalized" according to the rules for Python identifiers, i.e. dashes will be turned into underscores.

On the Ansible requirement

Does the above mean you have to learn Ansible in order to use float? Should you be concerned about investing effort into writing a configuration for my service in yet another configuration management system's language? The answer is *yes*, but to a very limited extent:

- You do need knowledge of how to set up an Ansible environment: the role of `ansible.cfg`, how to structure `group_vars` etc. Writing a dedicated configuration push system for float was surely an option, but we preferred relying on a popular existing ecosystem for this, both for convenience of implementation and also to allow a migration path of co-existence for legacy systems. To counter-balance, float tries to keep its usage of Ansible as limited as possible, to allow eventual replacement.

- Most services will only need an extremely simple Ansible role to generate the service configuration, normally a mix of *template* and *copy* tasks, which are possibly the most basic functionality of any configuration management system. This should guarantee a certain *ease of portability* to other mechanisms, should one decide to migrate away from float. Besides, it is a good sanity check: if your service requires complicated setup steps, perhaps it might be possible to move some of that complexity *inside* the service containers.

To emphasize portability, it might be wise to adhere to the following rules when writing Ansible roles:

- Try to use only *copy*, *file* and *template* tasks, rather than complex Ansible modules;
- avoid using complex conditional logic or loops in your Ansible tasks
- keep the configuration "local" to the service: do not reference other services except using the proper service discovery APIs (DNS), do not try to look up configuration attributes for other services (instead make those into global configuration variables);
- do not use facts from other hosts that need to be discovered (these break if you are not using a fact cache when doing partial runs): instead, define whatever host attributes you need, explicitly, in the inventory;

More generally, the integration with Ansible as the underlying configuration management engine is the "escape hatch" that allows the implemention of setups that are not explicitly modeled by float itself.

Infrastructure Part 1: Base Layer

We can subdivide what is done by float in two separate sections: operations and services affecting every host, the so-called "base" layer of infrastructure, and then the fundamental services that are part of the "cluster-level" infrastructure (logging, monitoring, authentication, etc): the latter are part of float but run on the base layer itself as proper services, with their own descriptions and Ansible roles to configure them.

Note that, in its default setup, float will naturally assume a two-tier service topology, with "frontend" hosts handling traffic routing in a stateless fashion, and "backend" hosts running the actual services. The default *services.yml.default* service description file literally expects the *frontend* and *backend* Ansible groups to be defined in your inventory. However, these are just roles, and there is nothing inherent in float that limits you to this kind of topology.

Service Discovery

"How do services find and talk to each other" is a fundamental aspect of any infrastructural platform. Float offers the following features:

- The ability to set up *overlay* networks to isolate service-to-service traffic from the public Internet.
- Services find each other with DNS A / AAAA lookups, so the client must know the target port. As a consequence, each service must use a globally unique port. This also implies that it’s impossible to schedule more than one instance of a service on each host.
- DNS views are used to provide topology-aware service resolution, so that hosts sharing a network overlay will route service requests over that network.
- Connections between services are direct, not mediated by proxies, so there is no global load balancing and clients are expected to keep track of the

state of backends and implement retry policies.
- Services can securely authenticate each other by using credentials automatically provided by the service mesh.

Float's implementation of this mechanism is extremely trivial and it is based on writing static entries to /etc/hosts. It is fundamentally limited in the number of services and hosts it can support.

Naming

Services are identified by their *name*, an alphanumeric string (it can also include dash '-' characters).

All DNS entries are served under an internal domain *domain*.

Every host has its own view of the DNS map. The specific IP addresses associated with a target service instance will depend on whether the source and target host share any network overlays, which will be used in preference to the public IP address of the backend host.

Locating service backends

The access patterns to backends of a distributed service vary depending on the service itself: for instance, with services that are replicated for high-availability, the client usually does not care which backend it talks to. In other cases, such as with *partitioned* services, clients need to identify individual backends.

We provide three ways of discovering the IP address of service backends. The port must be known and fixed at the application level.

Note that in all cases, the DNS map returns the *configured* state of the services, regardless of their health. It is up to the client to keep track of the availability status of the individual backends.

All backends

The DNS name for *service.domain* results in a response containing the IP addresses of all configured backends for *service*.

```
$ getent hosts myservice.mydomain
1.2.3.4
2.3.4.5
3.4.5.6
```

Note that due to limitations of the DNS protocol, not all backends may be discovered this way. It is however expected that a sufficient number of them will be returned in the DNS response to make high availability applications possible. If you need the full list of instances, it is best to obtain it at configuration time via Ansible.

Individual backends

Each service instance has a name that identifies it specifically, obtained by prepending the (short) host name to the service name:

```
$ getent hosts host1.myservice.mydomain
1.2.3.4
```

This is the hostname that the instance should use to advertise itself to its peers, if the service requires it.

Shards

Backends can also have permanent *shard* identifiers, that identify a specific backend host, and that do not change on reschedules. These are useful when a service is partitioned across multiple backends and the hosts have state or data associated with it. A shard identifier is an alphanumeric literal, specific to the host.

```
$ getent hosts shard1.myservice.mydomain
1.2.3.4
```

Master-elected services

When a service uses *master election*, an instance is automatically picked at configuration time to be the *master* of the service. This instance will be discoverable along with the other instances when resolving the service name. In addition, the special DNS name *service-master.domain* will point at it:

```
$ getent hosts myservice-master.mydomain
2.3.4.5
```

Network Overlay

It is possible to define internal networks that span multiple hosts, called *overlays*, which can then be used for service-to-service traffic, ignoring the details of the actual underlying public network topology.

For now, only a single IPv4 address can be assigned to a host on each private network. In the future, it should be possible to assign an entire subnet, so that individual IPs will be available to services.

The list of network overlays is part of the global float configuration, and to make a host participate in a network one should simply define a `ip_<network-name>` attribute for that host in the Ansible inventory, whose value should be the desired IP address.

The current implementation of private networking uses tinc and sets up a fully connected mesh between participating hosts. The result is robust and has limited performance overhead.

When the client and server hosts are on the same private network, the DNS-based service discovery will return the server's address on that private network, ensuring that service-to-service communication goes over the VPN.

Traffic Routing

While it's possible to configure it to do otherwise, *float* assumes that your services will run on its isolated, internal private networks, and it provides a mechanism to expose them publicly and route external traffic to the correct backend processes.

In the expected setup, one or more hosts should be dedicated to running the built-in *frontend* service (usually by setting up a host group and setting the service *scheduling_group* accordingly). Such hosts will have their public IP addresses advertised to the world via DNS. The *frontend* service runs a set of *request routers*, or reverse proxies (NGINX and HAproxy), to route requests to the correct service backends.

High-level traffic flow

Float uses a basic two-tier model for serving requests, with a reverse proxy layer between users and the backend applications. Traffic to the reverse proxies themselves (hosts running the *frontend* service) is controlled via DNS: float automatically creates low-TTL DNS records for its public endpoints. This has all the usual caveats of using DNS for this purpose, and it isn't really meant as a precise load-balancing layer.

Reliability is then provided by having multiple backends for the application itself: the reverse proxies will find one that works. It is important to note that, at the moment, float provides *no* accurate load-balancing whatsoever, just basic round-robin or random-selection: in NGINX, proper load balancing mechanisms are a paid feature.

HTTP

The infrastructure provides a way for HTTP-based services to expose themselves to the public Internet by defining public endpoints. The *public HTTP router* (NGINX) will be automatically configured based on such service metadata.

The clients of this service are users (or generically, external clients), not other services, which should instead talk directly to each other.

The public HTTP router will force all incoming requests to HTTPS.

For implementation details, see the nginx Ansible role README.

SSL Certificates

Float will automatically generate SSL certificates for the required public domain names. However, on first install, to ensure that NGINX can start while the ACME automation acquires the valid certificates, it will set up self-signed certificates, and switch to the ACME ones when they are available.

HTTP Cache

A global HTTP cache is available for services that require it.

NGINX will set the X-Cache-Status header on responses, so you can check if the response was cached or not.

The cache TTL is low (10 minutes), and there is currently no mechanism to explicitly purge the cache.

Controlling incoming HTTP traffic

The public HTTP router offers the possibility to block incoming requests based on their User-Agent (to ban bots, etc), or based on the URL they are trying to access. The latter is often required for regulatory compliance.

There is documentation of this functionality in the README files below the roles/float-infra-nginx/templates/config/block/ directory.

Non-HTTP

It is also possible to route arbitrary TCP traffic from the frontend hosts to the service backends. In this case, the proxy will not terminate SSL traffic or otherwise manipulate the request. The original client IP address will be unavailable to the service.

Define *public_tcp_endpoints* for a service to enable this feature.

Note that there is no functionality for reverse proxying UDP services: in this scenario you are probably better off scheduling your UDP service directly on the *frontend* group (or use a different group altogether and take care of DNS manually).

Public DNS

Float offers authoritative DNS service, it is part of the *frontend* service so it will run on the same hosts as the HTTP reverse proxies.

DNS entries are automatically generated for all known public_endpoints, as well as for the "public" domains in *domain_public*.

The DNS server is currently Bind, and is itself configured via an intermediate YAML-based language that supports templates and inheritance called zonetool.

There is the option of configuring DNSSEC (TODO: add docs).

Customizing DNS

If you want to set up a custom DNS zone, one way to do so is with a dedicated Ansible role (to be run on hosts in the *frontend* group) that installs your desired zonetool configuration.

Let's walk through a complete example: suppose we have a service *myservice* that should serve HTTP requests for the *myservice.org* domain. This doesn't match the *service_name.domain* scheme that is expected for services described in *services.yml*, so float won't automatically generate its DNS configuration.

What we need to do is set up the *myservice.org* DNS zone ourselves, and then tell float to associate that domain to the *myservice* service.

First, we create a new Ansible role that we are going to call *myservice-dns*, so in the root of your Ansible config:

```
$ mkdir -p roles/myservice-dns/{handlers,tasks,templates}
```

The only task in the role should install a zonetool DNS configuration file into */etc/dns/manual*, so in *roles/myservice-dns/tasks/main.yml* we'll have:

```yaml
---

- name: Install myservice DNS configuration
  template:
    src: myservice.yml.j2
    dest: /etc/dns/manual/myservice.yml
  notify: reload DNS
```

The DNS configuration in our case is very simple and just points "www" and the top-level domain at the frontends. We do so by extending the *@base* zone template defined by float. The contents of *roles/myservice-dns/templates/myservice.yml.j2* should be:

```yaml
---

myservice.org:
  EXTENDS: "@base"
  www: CNAME www.{{ domain_public[0] }}.
```

This points the www domain at the frontends via a CNAME (all the *domain_public* DNS zones are already autogenerated by float). We could have just as easily used A records but this is simpler and works with both IPv4 and IPv6.

Finally, we need a handler to reload the updated DNS configuration, which goes in *roles/myservice-dns/handlers/main.yml* and runs a shell command to update zonetool:

```yaml
---
```

```yaml
- listen: reload DNS
  shell: "/usr/sbin/update-dns && rndc reload"
```

With the above we have a complete Ansible role that configures DNS for the *myservice.org* domain. We need to tell Ansible that this role needs to run on the hosts in the *frontend* group, so in your playbook you should have:

```yaml
- hosts: frontend
  roles:
    - myservice-dns
```

And to complete our configuration, the service description for *myservice* should have a *public_endpoint* directive including the domain, so that the float HTTP router knows where to send the requests:

```yaml
myservice:
  ...
  public_endpoints:
    - name: myservice
      domains:
        - www.myservice.org
        - myservice.org
      port: ...
```

SSL

The internal ACME service continuously monitors the configured list of public domains and attempts to create or renew valid SSL certificates for them using Letsencrypt. It is integrated with the HTTP reverse proxy, so it will use the *http-01* ACME validation protocol, meaning that it is only able to create certificates for domains that have an A record pointing to float's frontend hosts.

To prevent issues with starting up daemons and missing certificates, float will at first generate placeholder self-signed certificates, so that services can use them even before the ACME automation has had a chance to create valid ones.

The certificates created by the ACME service are then replicated to all frontend hosts via the replds daemon, eventually ending up in the */etc/credentials/public* directory.

If a service that is *not* running on the frontend hosts needs access to the certificates, it can do so by depending on the *float-infra-acme-storage* role, e.g.:

roles/myservice/meta/main.yml

```yaml
---
dependencies:
  - {role: float-infra-acme-storage}
```

which will again ensure that the SSL certificates are present on the local host's /etc/credentials/public directory.

Access to the SSL certificates is controlled by membership in the *public-credentials* UNIX group.

If a service needs to be reloaded when its certificates change, it should install a shell script hook in the */etc/acme-storage/reload-hooks* directory. This script will be invoked every time *any* certificate changes, which is why the script should inspect whether the specific certificate it cares about has changed or not (possibly using something like the *if-changed* tool), to avoid excessive reloads:

```
#!/bin/sh
if-changed /etc/credentials/public/my.dom.ain/ \
    && systemctl restart myservice
exit 0
```

Generating additional SSL certificates

To customize the ACME server configuration, use a dedicated Ansible role that runs on the same group as the *acme* service, and dump a configuration file in /etc/acme/certs.d:

roles/myservice-acme/tasks/main.yml

```yaml
- name: Configure ACME for my custom domain
  copy:
    dest: /etc/acme/certs.d/mydomain.yml
    content: |
      - names:
        - "my.dom.ain"
```

playbook.yml

```yaml
- hosts: acme
  roles:
    - myservice-acme
```

SSH

Float can take over the SSH configuration of the managed hosts, and perform the following tasks:

- create a SSH Certification Authority
- sign the SSH host keys of all hosts with that CA
- add all the admin users' *ssh_keys* to the authorized_key list for the **root** user on all hosts.

The underlying access model is very simple and expects admins to log in as root in order to run Ansible, so you'll most likely want to set *ansible_user=root* and *ansible_become=false* in your config as well.

Keys used for login will be logged in the audit log, so you can still tell admins apart.

SSH Client Setup

You will find the public key for this CA in the *credentials/ssh/key.pub* file, it will be created the first time you run the init-credentials playbook.

Assuming that all your target hosts share the same domain (so you can use a wildcard), you should add the following entry to *~/.ssh/known_hosts*:

```
@cert_authority *.example.com ssh-ed25519 AAAAC3NzaC1lZDI1NTE5AAA....
```

Since all logins happen as root, it may be convenient to also add a section to your *~/.ssh/config* file like the following:

```
Host *.example.com
    User root
```

Integrating base services with other automation

Most float services that deal with config-driven autogenerated configurations support integrating with other, presumably service-driven, types of automation.

Consider, for example, the case of a platform for user web hosting: the main HTTP traffic routing infrastructure has to be extended with the configuration for all the user domains, which presumably comes out of a database somewhere.

In order to support such integration, services such as the HTTP router, DNS, ACME, and others, will also read their configurations from an *auto* directory (such as */etc/nginx/sites-auto* for example), which is not managed by float at all and that can be delegated to the external automation.

Infrastructure Part 2: Cluster Services

Authentication and Identity

The float infrastructure provides a full AAA solution that is used by all the built-in services, and that can be easily integrated with your services (or at least that would be the intention). It aims to implement modern solutions, and support moderately complex scenarios, while keeping things as simple as possible -- an area that could still see some improvement. It offers the following features:

- supports users and groups (mostly *admins* and eventually *users*)
- supports multiple backends (file, LDAP, SQL, ...)
- mechanisms for account recovery (currently poor, via secondary password, other mechanisms should be implemented)
- transparent upgrade of password hashing mechanisms (for future-proofing) (somewhat TODO)
- *single sign-on* for HTTP services
- TOTP and U2F authentication mechanisms for HTTP services

- supports passwords tied to specific services (wrongly called *application-specific*) for non-HTTP services
- manages secrets (encryption keys) encrypted with the user password, in a way that works even over single sign-on
- supports partitioned services
- configurable rate limits and blacklists for brute-force protection
- tracks logins and user devices without storing PII
- it is modular, and can be adapted to the desired scale / shape

However it is important to note that it comes with a very long list of caveats as well:

- the single sign-on system is implemented with bearer tokens (signed HTTP cookies), which have numerous weaknesses, even if one ignores the possible implementation failures:
  - bearer tokens are vulnerable to exfiltration (in logs, in user browser histories, caches, etc.), which can be partially mitigated by short token lifetimes
  - logout is a somewhat ill-defined operation (the current implementation relies on borderline-*adtech* techniques in order to delete cookies on other services' domains)
  - they rely on a complex chain of HTTP redirects and HTTP headers being set in the right place

Most of these features do not have immediate use in the basic services built-in into the infrastructure, but they are meant instead for the primary use case for *float*: the implementation of a large-ish email and hosting provider.

It should therefore be clear that the chosen design involves numerous trade-offs, some of which we have tried to document here, that are tailored to the above use case, and might very well not be suitable to your particular scenario.

In float, the primary user authentication database is provided via a global variable in your Ansible configuration and controls access to the internal web-based services that are behind single sign-on.

Authentication

All credentials-based authentication (passwords, OTP, U2F) goes through the main authentication daemon auth-server. It translates authentication requests, containing service name, user name, password, and other authentication parameters, into database requests to retrieve the authentication primaries and verify them.

An authentication response has one of three possible states: failure, success, and the request for further authentication with a second factor (OTP or U2F, in which case the response will also contain U2F challenge parameters). On a successful response, the auth-server might return additional data such as an email address. The auth-server listens on a UNIX socket, so it usually runs on all machines, and speaks a simple line-based protocol. There is also a PAM module available to help integrate your services.

Database lookup queries can be configured separately for each supported service, along with a number of other parameters.

The default setup in *float* uses a file-based backend for administrator accounts (in the *admin* group), and eventually a LDAP database for user accounts (LDAP was a requirement of the main float use case, SQL support should be added instead).

The auth-server can log authentication events and the associated client and device information to long-term storage, and it can detect anomalies and take action (the standard use case is "send an email when you see a login from a new device").

Why not PAM? PAM is not exactly a nice interface, furthermore it isn't exactly easy to pass arbitrary information through its conversation API (required for OTP/U2F). Furthermore, there are many advantages in using a standalone authentication server: centralization of rate limits across different services, a single point for logging, auditing and monitoring, and a single ownership of database authorization credentials.

References

- git.autistici.org/id/auth, the main auth-server code.
- git.autistici.org/id/usermetadb, a privacy-preserving long-term user-focused audit data store (lots of words for a SQL database with a simple API).

Single sign-on

The single sign-on functionality is implemented using sso, a very simple scheme based on Ed25519 signatures. The SSO functionality is split between a bunch of libraries that implement token validation for various languages and environments (including a PAM library and an Apache module), and a server that handles all the HTTP authentication workflows. For simplicity, this server also serves the login page itself.

Why not SAML, or any of the other SSO technologies available? Well, first of all nothing fit exactly the "simplicity" requirement... (and most of the client SAML libraries available are somewhat awful) but in the end what we have isn't very different from SAML, except without all the XML and weird enterprise edge cases.

References

- git.autistici.org/ai/sso original C implementation and design reference, Python bindings, PAM / Apache2 modules.
- git.autistici.org/id/go-sso SSO server and SSO proxy implementation.

- the sso-server role README has details about the Ansible configuration of SSO parameters.

User-encrypted secrets

There is functionality to maintain a secret associated with every user, usually a private key used for encrypting user data, in such a way that it can only be decrypted by the user itself, using the password (or any other equivalent form of authentication primary).

The implementation maintains a number of copies of the encrypted password, each encrypted with one of the authentication primaries: the user's main password, the secondary password used for recovery, and the various application-specific passwords if present. This way, each service that successfully authenticates the user can immediately decrypt the secret by trying all the available encrypted secrets with the password it has.

Single sign-on integration is provided by a dedicated service that decrypts keys when the user initially logs in on the SSO server (the only time in the SSO workflow when we have access to the password), and keeps it around until the login expires.

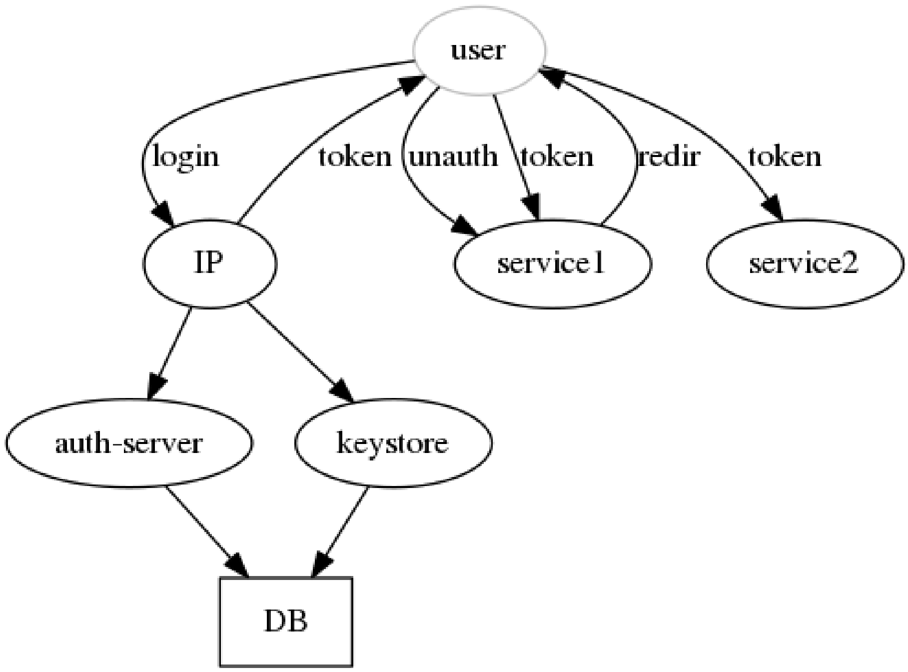
References

- git.autistici.org/id/keystore, the key storage service, includes a dedicated Dovecot dict proxy interface (Dovecot is the primary use case for the encrypted secrets feature).

Authentication workflows

In this section we try to document step-by-step the various authentication workflows, to illustrate the interactions between the various authentication-related services described above.

Single sign-on

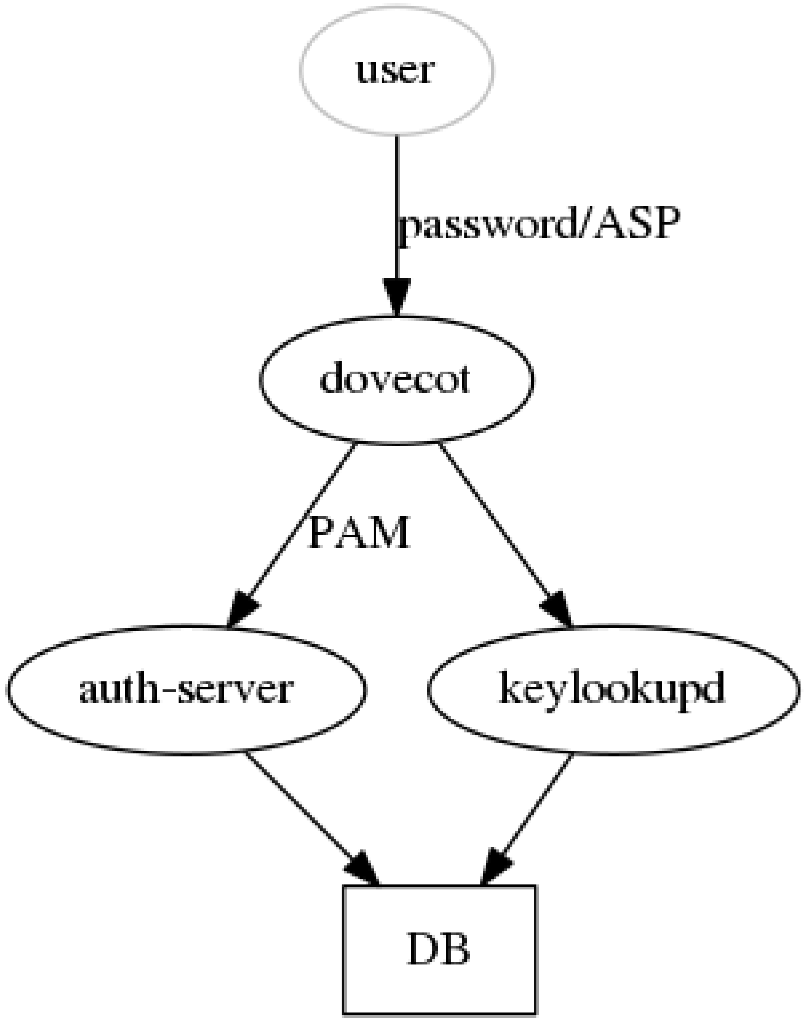


1. The first time a user connects to *service1*, it is redirected to the IP (*identity provider*).
2. The IP handles the authentication UX (form with username and password, OTP, U2F, etc).
3. The IP verifies the credentials with the authentication server.
4. The authentication server verifies the credentials against what is in the database. If the credentials are good but incomplete (i.e. we have the right password but no 2FA), go back to step 2 and ask for the second factor.
5. The IP uses the user password to unlock the user's key by calling the keystore service.
6. The keystore fetches the key from the database, decrypts it, and caches it in memory.

When the SSO token for *service1* expires, and the user is once again redirected back to the IP, the identity provider can skip the authentication process (if it recognizes the user) and simply create a new valid token straight away. This process is transparent to the user (well, for GET requests at least).

Non-HTTP service login

Let's take *dovecot* as an example of a non-HTTP service.



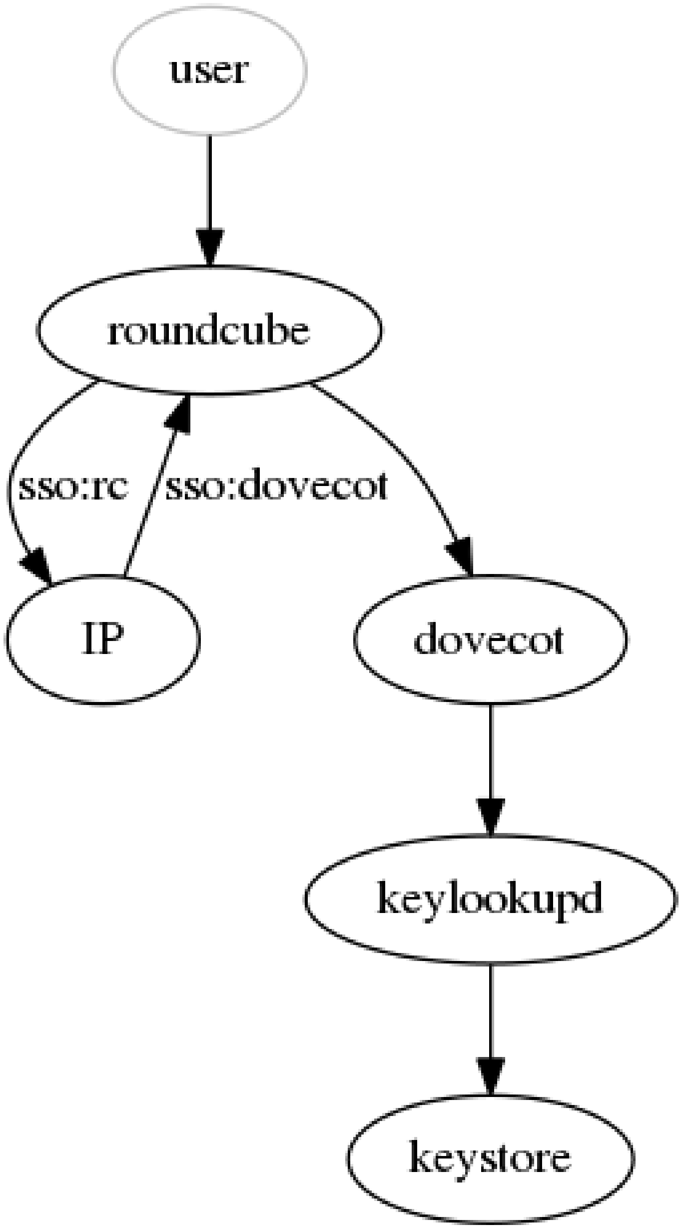
1. The user connects to dovecot using an IMAP client. The client sends credentials that look like a password, which are either:
    - the user's primary password (for users without 2FA), or
    - a service-specific password valid for the *dovecot* service
2. Dovecot verifies the credentials with the authentication server, using PAM (dovecot supports many ways to plug in a custom authentication protocol, PAM is just one of them).
3. The authentication server verifies the credentials against what is in the database. There is no support for "incomplete" credentials here because the IMAP protocol is not conversational.
4. Dovecot fetches the (decrypted) user encryption key from keylookupd, sending it the credentials used in the IMAP login. It will keep this key in

memory for the duration of the IMAP connection.

5. Keylookupd fetches the (encrypted) user encryption key from the database and decrypts it using the credentials.

Third-party service authentication

Let's examine a more complex interaction, where a HTTP-based service (*roundcube*, a webmail application) needs to access internally a different service (dovecot, in order to read the user's email).



1. The user has a valid SSO token for the *roundcube* service, and connects to the roundcube web application.
2. Roundcube exchanges the user SSO token for another one that is valid for the *dovecot* service, by using the "exchange" API of the IP (identity provider).
3. The IP verifies that the roundcube SSO token is valid, and that the

roundcube -> dovecot transition is authorized (via a whitelist). It signs a new token for the same user with the new service "dovecot".
4. Roundcube talks to dovecot and logs in on behalf of the user providing this new SSO token as the password.
5. Dovecot verifies that the username and SSO token are valid (using *pam_sso*), and retrieves the (decrypted) user encryption key from the keystore.
6. The keystore already has the (decrypted) user encryption key cached in memory because at some point in time *before* accessing the roundcube web application, the user has logged in to the IP, which has unlocked the key in keystore (see the "single sign-on" workflow description above, step 6).

Monitoring

Float provides Prometheus as its monitoring service, and it will automatically configure it to scrape your services for metrics if this information is provided in the service metadata.

It comes with a pre-defined set of rules and alerts that should catch major problems with the services running on the float infrastructure, though it is advisable to add higher-level application-specific criteria to better capture the specific characteristics of your services.

Prometheus runs as the *prometheus* service (in the default service configuration) and associated Ansible role. The service is set up in such a way to easily and unobtrusively scale along with your infrastructure:

- it is possible to run multiple instances of the main *prometheus* service, for reliability purposes. Float uses Thanos to transparently aggregate results from multiple instances.
- it is possible to separate short-term and long-term metrics storage by using the *prometheus-lts* service to scrape the other Prometheus instances and retain metrics long term. The Thanos layer will again transparently support this configuration. See the *Scaling up the monitoring infrastructure* section below for details.

Monitoring dashboards are provided by Grafana.

Customizing alerts

A few alerting rules are provided by default in roles/prometheus/files/rules/. This includes:

- host-level alerts (high CPU usage, disk full, network errors...)
- service failures (systemd services down, or crash-looping)
- HTTP errors on *public_endpoints*

To add your own alerts, you may want to create your own Ansible role with the necessary rule and alert files, and schedule it to execute on hosts in the *prometheus* group, e.g.:

roles/my-alerts/tasks/main.yml

```
- copy:
    src: rules/
    dest: /etc/prometheus/rules/
```

playbook.yml

```
- hosts: prometheus
  roles:
    - my-alerts
```

and your custom rules / alerts would be in *roles/my-alerts/files/rules/*.

The alertmanager configuration expects some common labels to be set on your alerts in order to apply its inhibition hierarchy (and make alerting less noisy):

- `severity` should be set to one of *warn* (no notification) or *page*
- `scope` should be one of *host* (for prober-based alerts), *instance* (for all other targets), or *global*.

Scaling up the monitoring infrastructure

Float upholds the philosophy that collecting lots and lots of metrics is actually a good thing, because it enables post-facto diagnosis of issues. However, even with relatively small numbers of services and machines, the amount of timeseries data that needs to be stored will grow very quickly.

Float allows you to split the monitoring data collection into two logical "parts" (which themselves can consist of multiple identical instances for redundancy purposes), let's call them *environments* to avoid overloading the term *instance*:

- A *short-term* Prometheus environment that scrapes all the service targets with high frequency, evaluates alerts, but has a short retention time (hours / days, depending on storage requirements). Storage requirements for this environment are bounded, for a given set of services and targets.

- A *long-term* Prometheus environment that scrapes data from the short-term environment, with a lower frequency, and discarding high-cardinality metrics for which we have aggregates. The storage requirement grows much more slowly over time than the short-term environment. Float calls this service *prometheus-lts* (long-term storage).

This effectively implements a two-tiered (high-resolution / low-resolution) time-series database, which is then reconciled transparently when querying through the Thanos service layer.

To enable long-term metrics storage, include *services.prometheus-lts.yml* in your service definitions, and add the corresponding *playbooks/prometheus-lts.yml* playbook to your own.

You will also need to set *prometheus_tsdb_retention* and *prometheus_lts_tsdb_retention* variables appropriately.

Log Collection and Analysis

Logs are forwarded by all machines to a set of (one or more) *log-collector* instances. These log-collector instances receive logs over syslog/tcp (with SSL) and store them locally for search and aggregation purposes.

Logs are only written to disk in the centralized collector, all process logs are gathered by journald (which stores them in memory). Anonymization is also performed centrally on the collector, so that only anonymized logs are ever persisted to disk.

Log types

There are three main log types at the moment, though more might be added:

- Standard *syslog logs*
- *HTTP logs*, generated in a specific format (an extension of the Apache Combined Log format) by our NGINX front-ends, which use the syslog facility *local3*, exclusively dedicated to this purpose
- *structured logs*, which are generated by applications in CEE/lumberjack format (simply a JSON dictionary prepended by the literal string `@cee:`).

Metric extraction

It is often useful to extract real-time metrics from logs, most often when dealing with software that does not export its own metrics. An example is NGINX, where logs are parsed in order to compute real-time access metrics. Float runs an instance of mtail on every host to process the local logs and compute metrics based on them.

Custom rules can be added simply by dropping mtail programs in */etc/mtail*. This would generally be done by the relevant service-specific Ansible role.

Metadata extraction

Syslog logs received by the log-collector will be subject to further processing in order to extract metadata fields that will be stored and indexed. Metadata extracted from logs is useful for searching and filtering, even though those cases are already well served by full-text search (or *grep*), and most importantly for aggregation purposes: these can be either used for visualizations (dashboards), or for analytical queries, that would be difficult to answer using the coarse view provided by monitoring metrics.

Perhaps it's best to make an example to better illustrate the relation between metadata-annotated logs and monitoring metrics, especially log-derived ones, which are obviously related being derived from the same source. Let's consider the canonical example of the HTTP access logs of a website which is having problems: the monitoring system can tell which fraction of the incoming requests is returning, say, an error 500, while properly annotated logs can answer more detailed queries such as "the list of top 10 URLs that have returned an error 500 in the last day". The extremely large cardinality of the URL field (which is user-controlled) makes it too impractical to use for monitoring purposes, but the monitoring metric is cheap to compute and easy to alert on in real-time, while the metadata-annotated logs provide us with the (detailed, but more expensive to compute) analytical view.

The implementation uses the mmnormalize rsyslog module, which parses logs with the liblognorm engine to extract metadata fields.

Liblognorm rulebase files are a bit verbose but relatively simple to write. Rules can be manually tested using the *lognormalizer* utility, part of the *liblognorm-utils* Debian package.

Additional rules should be dropped in the */etc/rsyslog-collector-lognorm/* directory of the hosts where the *log-collector* service is running, via a custom Ansible role:

roles/my-lognorm/tasks/main.yml

```yaml
- copy:
    src: rules/
    dest: /etc/rsyslog-collector-lognorm/
```

playbook.yml

```yaml
- hosts: log-collector
  roles:
    - my-lognorm
```

assuming *roles/my-lognorm/files/rules/...* would contain your lognorm rules.

Technical implementation details

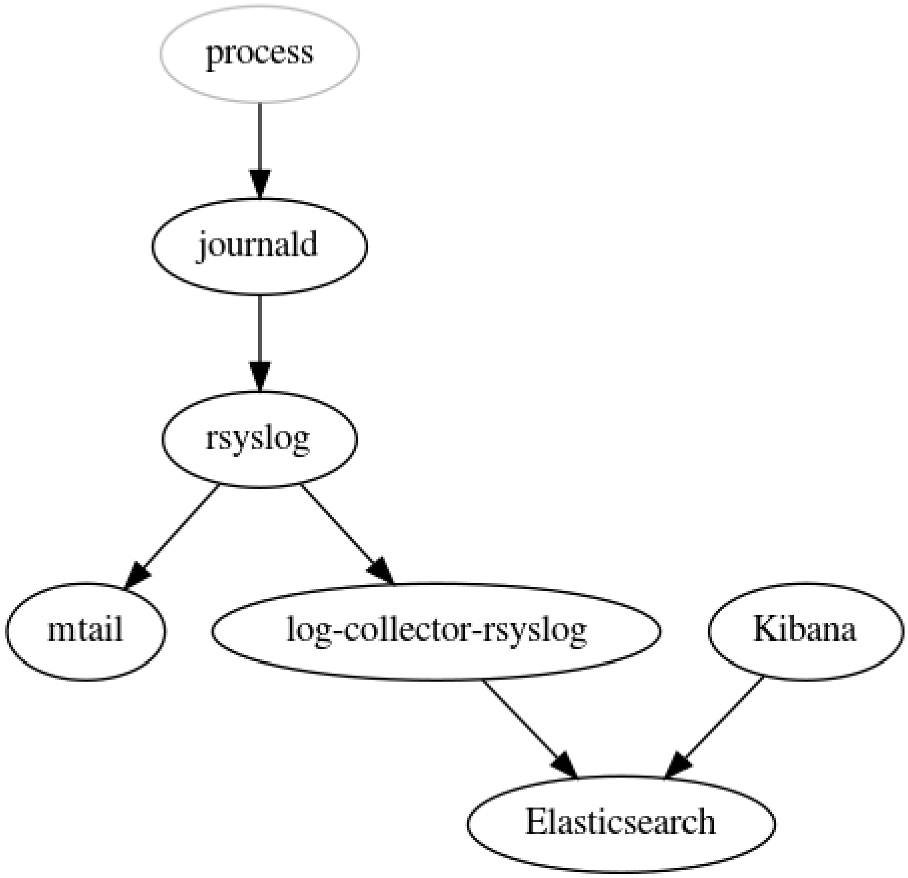
The logging stack on each individual machine looks like the following:

- The local *rsyslogd* collects logs from the systemd journal and the default syslog socket, and sends logs to the centralized log collectors.
- It also runs a *mtail* instance on the local log stream, scraped by the monitoring system, allowing us to derive custom metrics from logs.

The log-collector instances run a minimalistic ELK-like stack, where Logstash has been removed and its functionality reproduced in rsyslogd itself:

- A separate instance of *rsyslogd* listens for incoming logs on port 6514 (the standard syslog-tls service), and forwards logs, after some processing, to Elasticsearch.
- Elasticsearch stores logs on the local disk.

- Kibana is used to provide a web query front-end to the archived logs, in addition to the *logcat* command-line tool.



The structure of Elasticsearch indexes match what would have been produced by Logstash (and what is expected by Kibana), with daily indexes. Float uses the following index types:

- *logstash-** for all standard syslog / journald logs
- *http-** for HTTP accesses to the frontend reverse proxies
- *audit-** for audit logs, which usually have a longer retention

We use Elasticsearch index templates (in roles/log-collector/templates/elasticsearch/templates) to optimize the schema a bit, disabling indexing on problematic fields, and setting sane replication options.

Configuration

Float is an Ansible plugin with its own configuration, that replaces the native Ansible inventory configuration. You will still be running Ansible (`ansible-playbook` or whatever frontend you prefer) in order to apply your configuration to your production environment. Float only provides its own roles and plugins, but it does not interfere with the rest of the Ansible configuration: playbooks, host and group variables, etc. which will have to be present for a functional setup.

The toolkit configuration is split into two parts, the *service description metadata*, containing definitions of the known services, and a *host inventory*, with information about hosts and group (the same information you would have in a normal Ansible inventory). A number of global Ansible variables are also required to customize the infrastructure for your application.

All configuration files are YAML-encoded and should usually have a *.yml* extension.

Float is controlled by a top-level configuration file, which you should pass to the ansible command-line tool as the inventory with the *-i* flag. This file mainly consists of pointers to the more specific configuration files:

```yaml
services_file: services.yml
passwords_file: passwords.yml
hosts_file: hosts.yml
credentials_dir: credentials/
plugin: float
```

This file **must** exist and it must contain at the very least the "plugin: float" directive.

The attributes supported are:

`services_file` points at the location of the file containing the service metadata definition, the default is *services.yml*.

`hosts_file` points at the location of the hosts inventory, the default being *hosts.yml*.

`passwords_file` points at the configuration of the application credentials (passwords), with default *passwords.yml*.

`credentials_dir` points at the directory where autogenerated service-level credentials (PKI-related) will be stored. This is often managed as a separate git repository.

`plugin` must always have the literal value *float*.

Relative paths in *float* configuration files are interpreted as relative to the configuration file being evaluated. Among other things, this results in the possibility of using relative paths in *include* directives.

Inventory (*hosts.yml*)

The inventory file defines *hosts* and *groups*, and custom variables associated with those. It's just another way of defining an Ansible inventory that is easy for us to inspect programatically.

The groups defined here can be used in your own Ansible playbook, but most importantly are used in *services.yml* to make scheduling decisions (see Scheduling below).

The inventory file must contain a dictionary encoded in YAML format. The top-level attributes supported are:

`hosts` must contain a dictionary of *name*: *attributes* pairs defining all the hosts in the inventory;

`group_vars` can contain a dictionary of *group_name*: *attributes* pairs that define group variables.

Groups

While you can define any host groups you want, the default service configuration in float (*services.yml.default*) expects you to define at least two:

- *frontend*, for the public-facing reverse proxy hosts
- *backend*, for hosts where the actual services will run

While nothing prevents a host from being in both (for instance if you are running a single test host), or you from overriding the *scheduling_group* assignments in the default service configuration. This default is a consequence of the fact that the default service model is oriented towards a request-based two-tiered design.

Host variables

Variables can be Ansible variables: SSH parameters, etc., usually with an *ansible_* prefix. But some host variables have special meaning for float:

`ip` (mandatory) is the IPv4 address of this host that other hosts (i.e. internal services) should use to reach it

`ip6` (optional) is the IPv6 version of the above

`public_ip` (optional) is the IPv4 address that will be advertised in the public-facing DNS zones, if unset it defaults to `ip`

`public_ip6` (optional) is the IPv6 version of the above

`ip_<name>` (optional) defines the IPv4 address for this host on the overlay network called *name*

`groups` (optional) is a list of Ansible groups that this host should be a member of `resolver_mode` (optional) controls the desired state of the host's *resolv.conf* file. The supported values are:

- *ignore* - do nothing and leave resolv.conf alone
- *localhost* - use localhost as a resolver, presumably some other role will have installed a DNS cache there
- *internal:NET* - use the frontend hosts as resolvers, over the specified overlay network named NET
- *external* - use Google Public DNS.

Note that due to ordering issues it is advised to set the *resolver_mode* attribute on hosts only after the first setup is complete, to avoid breaking DNS resolution while Ansible is running.

Example

An example of a valid inventory file (for a hypotetic Vagrant environment):

```yaml
hosts:
  host1:
    ansible_host: 192.168.10.10
    ip: 192.168.10.10
    groups: [frontend, vagrant]
  host2:
    ansible_host: 192.168.10.11
    ip: 192.168.10.11
    groups: [backend, vagrant]
group_vars:
  vagrant:
    ansible_become: true
    ansible_user: vagrant
    ansible_ssh_private_key_file: "~/.vagrant.d/insecure_private_key"
```

This defines two hosts (*host1* and *host2*), both part of the *vagrant* group. Some Ansible variables are defined, both at the host and the group level, to set Vagrant-specific connection parameters.

Service metadata (*services.yml*)

The service metadata file (*services.yml*) is a dictionary encoded in YAML format, where keys are service names and values contain the associated metadata. This file is consumed by the static service scheduler that assigns services to hosts, and by the Ansible automation in order to define configuration variables.

Service metadata is encoded as a dictionary of *service name*: *service attributes* pairs, each defining a separate service.

Metadata for services that are part of the core infrastructure ships embedded with this repository, so when writing your own `services.yml` file, you only need to add your services to it. You should include the *services.yml.default* file shipped with the float source, which defines all the built-in services:

```yaml
include:
  - "/path/to/float/services.yml.default"
```

The `include` directive is special: it does not define a service, but it expects a list of other files to include, containing service definitions. These are evaluated before the current file, and the results are merged, so it is possible to override parts of an included service definition.

It is possible to override service metadata attributes defined in an included file, for instance consider the following two files:

- `base.yml`

```yaml
foo:
  scheduling_group: foo-hosts
  num_instances: 1
```

- `services.yml`

```yaml
include:
  - "base.yml"
foo:
  num_instances: 2
```

The resulting *foo* service will have *num_instances* set to 2. Note that the merging algorithm is trivial and it's not possible to extend or modify a list (it can only be overridden).

Since the service attributes are many, we'll examine them grouped by major area of functionality.

Scheduling

Attributes that control how a service is scheduled on the available hosts.

`scheduling_group`: Only schedule the service on hosts of the specified host group. By default, schedule on all hosts. If one needs to specify multiple groups, use the plural `scheduling_groups` variant of this attribute.

`num_instances`: Run a limited number of instances of the service (selected among the hosts identified by the `scheduling_group`). By default this is set to `all`, which will run an instance on every host.

`master_election`: If true, pick one of the hosts as master/leader (default is false).

Credentials

Float creates a UNIX group to access each set of service-level credentials separately, named *credentials_name*-credentials.

`service_credentials`: A list of dictionaries, one for each service credential that should be generated for this service.

Each *service_credentials* object supports the following attributes:

`name` (mandatory): Name for this set of credentials, usually the same as the service name. Certificates will be stored in a directory with this name below `/etc/credentials/x509`.

`enable_client`: Whether to generate a client certificate (true by default).

`client_cert_mode`: Key usage bits to set on the client certificate. One of *client*, *server*, or *both*, the default is *client*.

`enable_server`: Whether to generate a server certificate (true by default).

`server_cert_mode`: Key usage bits to set on the server certificate. One of *client*, *server* or *both*, the default is *server*.

`extra_san`: Additional DNS domains to add as subjectAltName fields in the generated server certificate. This should be a list. The internal domain name will be appended to all entries.

Monitoring

`monitoring_endpoints`: List of monitoring endpoints exported by the service.

Each entry in the *monitoring_endpoints* list can have the following attributes:

`job_name`: Job name in Prometheus, defaults to the service name.

`type` (deprecated): Selects the service discovery mechanism used by Prometheus to find the service endpoints. This can only have the value *static*, which is also the default.

`port`: Port where the `/metrics` endpoint is exported.

`scheme`: HTTP scheme for the service endpoint. The default is *https*.

`metrics_path`: Path for metrics if different from the default of `/metrics`.

Traffic routing

Services can define *public* HTTP and TCP endpoints, that will be exported as subdomains of the public domain name by the public traffic routing infrastructure.

Normally DNS entries and SSL certificates are created for all public endpoints. This automation can be switched off by setting the `skip_acme` or `skip_dns` attributes to *true* (if for some reason you need to customize these parts manually).

HTTP

`public_endpoints`: List of HTTP endpoints exported by the service that should be made available to end users via the service HTTP router.

All *public_endpoints* will be made available to public users under their own subdomain of each *domain_public* (unless the *domains* attribute is used), over HTTPS, on the default HTTPS port (443).

Entries in the public endpoints list can have the following attributes:

`name`: Public name of the service. This can be different from the service name, for instance you might want to export the internal *prometheus* service as *monitoring* under the user-facing external domain name. This name will be prepended to each one of the domains listed in *domain_public* to obtain the public FQDNs to use. Alternatively, you can define one or more *domains*.

`domains`: List of fully qualified server names for this endpoint, in alternative or in addition to specifying a short *name*.

`port`: Port where the service is running.

`scheme`: HTTP scheme for the service endpoint. The default is *https*.

`autoconfig`: If False, disable generation of the NGINX configuration for this host - it is assumed that some other automation will do it.

`extra_nginx_config`: Additional NGINX directives that should be included (at the *server* level) in the generated configuration.

HTTP (All domains)

`horizontal_endpoints`: List of HTTP endpoints exported by the service, that should be made available to end users on all domains served by the infrastructure - normally used for */.well-known/* paths and such.

Entries can have the following attributes:

`path`: Path that should be routed to the service, e.g. */.well-known/something*. It should not end with a slash.

`port`: Port where the service is running.

`scheme`: HTTP scheme for the service endpoint. The default is *http*.

TCP

`public_tcp_endpoints`: List of TCP endpoints to be publicly exported by the service.

Entries in the *public_tcp_endpoints* list can have the following attributes, all required:

`name`: Name of the endpoint.

`port`: Port where the service is running. Also the port that will be publicly exported (at least in the current implementation), which unfortunately means that the service itself shouldn't be running on *frontend* nodes.

`use_proxy_protocol`: When true, enable the HAProxy proxy protocol for the service, to propagate the original client IP to the backends.

Other endpoints

Other endpoints are used when the service runs their own reverse proxies, but we'd still like *float* to take care of generating DNS entries and SSL certificates for it.

`public_other_endpoints`: List of other endpoints to be publicly exported by the service.

Entries in the endpoints list can have the following attributes, all required:

`name`: Name of the endpoint.

Containers

`containers`: List of containerized instances that make up the service (for container-based services).

Each entry in this list represents a containerized image to be run. Supported attributes include:

`name`: Name of the container. It is possible to have containers with the same name in different services.

`image`: Which Docker image to run.

`port`: Port exposed by the Docker image. It will be exposed on the host network interface.

`ports` (in alternative to `port`): List of ports exposed by the Docker image. Use when you need a list, in place of `port`.

`docker_options`: Additional options to be passed to the `docker run` command.

`args`: Arguments to be passed to the container entry point.

`volumes`: Map of *source*:*target* paths to bind-mount in the container. If the *source* is literally `tmpfs`, we will mount a tmpfs filesystem (with a default size of 64MB) instead.

`root` (boolean, default: false): if set, the container will run as root, instead of the dedicated service-level user. Enabling this option automatically sets *drop_capabilities* to false.

`drop_capabilities` (boolean, default: true): if set, causes Docker to drop all capabilities for this container. Otherwise, the capability set will be controlled by systemd.

Non-container services

`systemd_services`: List of systemd service units that are associated with this service. Setting this attribute does nothing (the dedicated Ansible role is expected to install the package fully, including setting up systemd), except providing grouping information to help *float* generate monitoring dashboards. Note that float will actively turn down (disable, mask) these units on the hosts where they are not scheduled.

Additional service ports

Ports declared in *public_endpoints* and *containers* are automatically allowed internal traffic on the host firewall. But often internal services may want to expose ports to other internal clients: these ports should be declared in the service definition so that *float* can configure the firewall accordingly.

`ports`: List of ports exposed by the service over the internal overlay networks (traffic will be allowed for both UDP and TCP).

Datasets

`datasets`: List of dataset definitions.

Each dataset definition can have the following attributes:

`name`: Name of the dataset (mandatory).

`schedule`: A schedule on which to run the backup job for this dataset. This can be either a time specification in the standard *cron* format, or the special syntax

> `@random_every` *interval*

which schedules the backup job at a random offset for each host within the specified interval. Intervals can be written in a human-friendly syntax like *7d* or *12h*. This is the fundamental mechanism for spreading the load of the different hosts on the backup server without central coordination. If unspecified, the default is "@random_every 1d".

`path`: Local (on each host) filesystem path that contains the dataset. This selects the *file* type for the dataset, and is alternative to the *backup_command* / *restore_command* attributes.

`backup_command` / `restore_command`: Shell commands for backing up datasets via stdin/stdout pipes. If these attributes are specified, the source is of *pipe* type. They are alternative to the *path* attribute.

`on_master_only`: If this attribute is true, and the service's *master_election* attribute is also true, the backup job will only be run on the master host for the service.

`sharded`: When this attribute is true, the dataset is considered a sharded (partitioned) dataset, so float will **not** automatically attempt to restore it on new servers: the idea is that for sharded datasets, the application layer is responsible for data management. This attribute is false by default.

`owner`, `group`, `mode`: For filesystem-backed datasets, float will create the associated directory if it does not exist; these parameters specify ownership and permissions. These permissions will also be reset upon restore.

Volumes

`volumes`: List of volume definitions describing LVs required by the service.

Each volume definition can have the following attributes:

`name`: Volume name (mandatory).

`path`: Path where it should be mounted (mandatory).

`owner`: Owner of the mountpoint (default: root).

`group`: Group of the mountpoint (default: root).

`mode`: Mountpoint mode (default: 0755).

The LVs are created in the volume specified by the `volumes_vg` global configuration variable, which by default is *vg0*. The VG must already exist, float will not attempt to create it.

Examples

Let's look at some example *services.yml* files:

```yaml
myservice:
  num_instances: 2
  service_credentials:
    - name: myservice
      enable_client: false
  public_endpoints:
    - name: myservice
      type: static
      port: 1234
  systemd_services:
    - myservice.service
```

This defines an Ansible-based service, of which we'll run two instances. The service exposes an HTTP server on port 1234, which, assuming *domain_public* is set to `mydomain.com`, will be available at https://myservice.mydomain.com/ on the nginx service gateways of the *core* role. Communication between the HTTPS gateway and the service goes over HTTPS internally using auto-generated credentials.

```
myservice:
  containers:
    - name: myapp
      image: myapp:latest
      port: 1234
    - name: redis
      image: redis
      port: 6379
  public_endpoints:
    - name: myservice
      type: static
      port: 1234
      scheme: http
```

The above describes a container-based service, consisting of two separate processes: a web application, and a local Redis server (maybe for caching). The two processes will always be scheduled together, so *myapp* can be configured to talk to Redis on localhost:6379. This time, the service gateway will talk to *myapp* over HTTP.

This service does not have any service credentials, but if it did they would be bind-mounted under */etc/credentials* inside the container.

Application credentials (*passwords.yml*)

This file contains a description of all the application-level credentials that should be automatically managed by *float*: these secrets will be randomly generated by float, and stored in a Vault-encrypted file (*secrets.yml* in your *credentials_dir*). This creation step is part of the *init-credentials.yml* Ansible playbook (see *Built-in playbooks* below).

The credentials configuration file must contain a list of dictionaries, each describing a separate credential. Supported attributes include:

- `name` is the name of the Ansible variable that will be created in the resulting YAML file (mandatory)
- `description` is a human-readable description of what the credential represents
- `type` can be one of either *password* (the default) or *binary*, and it controls the character set of the resulting password. Right now, due to the requirement of command-line friendliness (it appears that Ansible is unable to correctly encode arbitrary strings when generating remote commands), both use the base64 charset.
- `length` is the desired length of the output.

A list element can, alternatively, contain a single `include` attribute, in which case the contents of that file will be added to the credentials list.

At the bare minimum, your *passwords.yml* file should include the *passwords.yml.default* file from the float source tree, which contains all the credentials for the built-in services:

```yaml
---
- include: "/path/to/float/passwords.yml.default"
```

Global configuration variables

In order to customize the final environment for *your* installation, there are some global configuration variables that you should set. These are standard Ansible variables, and Ansible supports a few ways to define them: one way would be to add them to the *all* group in the inventory itself, but more conveniently, they can just be placed in a YAML file *group_vars/all* somewhere next to it.

These variables are:

`domain` (mandatory) is the *internal* domain name used for hosts and internal service resolution. It is strongly suggested to use a dedicated domain for this purpose, so it should be different from any public domain you expect to be using (but it can be a subdomain of it, for instance *internal.example.com*). With the current implementation, there's no need for this domain to publicly exist at all, as name resolution is done via /etc/hosts, but this may change in the future.

`domain_public` (mandatory) should contain a list of the public domain names that will be used by the global HTTP router to export public HTTP service endpoints. This is useful when public services should be reachable equally on separate indipendent domains, like a primary one and a Tor Hidden Service. If specifying multiple names, put the default public one first - the first element of this list is used whenever we need a human-readable identifier.

`testing` is a boolean variable, True by default, that indicates whether we are running on a test or production environment. In test environments, a number of variables have different defaults (see the *Testing* section below).

`float_debian_dist` (default *buster*) is the Debian distribution that will be installed by float on the target servers.

Network overlays

The `net_overlays` configuration variable should contain the list of configured network overlays, each item a dictionary with the following attributes:

- `name` - name of the overlay network
- `network` - the IP network range in CIDR format
- `port` (optional) - port used by the transport layer (default 655)

More transport-specific parameters are available, for the exact details see the documentation of the net-overlay Ansible role.

Admin users

The `admins` configuration variable contains a list of admin users, each a dictionary with the following attributes:

- `name` - the username
- `email` (optional) - user's email address
- `password` - encrypted password. For a list of supported algorithms, check the id/auth documentation.
- `totp_secret` - TOTP secret for 2FA, base32-encoded
- `ssh_keys` - a list of strings representing SSH public keys
- `u2f_registrations` - a list of objects representing U2F token registrations

Authentication and SSO

`enable_keystore` - whether to enable the keystore service for user-encrypted secrets (default false)

`sso_server_url` - URL for the SSO service. This should match the public_endpoint name for the *sso-server* float service (default: https://login + *domain_public[0]*).

`sso_extra_allowed_services` - list of regular expressions for SSO-enabled services that are allowed to use the SSO server. All your SSO-enabled services should be added to this list.

`sso_allowed_exchanges` - list of items with *src_regexp* / *dst_regexp* attributes that identify valid source and destination SSO service specifications for token exchange.

SSH

`enable_ssh` (defaults to true) controls whether float will create a SSH CA and sign host keys with it, as well as managing the *authorized_keys* of the root user. When set to false, no changes whatsoever will be made to the SSH configuration of the hosts.

DNS

`static_host_entries` - a list of entries with *host* and *addr* attributes that specify static DNS entries that will be added to /etc/hosts on every target host.

Traffic router

`nginx_cache_keys_mem` is the memory size of the key buffer for the global NGINX HTTP cache.

`nginx_cache_fs_size` is the maximum on-disk size of the NGINX HTTP cache (note that NGINX might use as much as twice what specified here, depending on expiration policy).

`nginx_global_custom_headers` - a dictionary of {header: value} pairs corresponding to HTTP headers that must be set on *every* response.

`nginx_top_level_domain_redirects` - a dictionary of {domain: target} tuples used for redirecting top-level domains to specific destinations (DNS must be managed manually).

Logging

`enable_elasticsearch` controls whether to enable the Elasticsearch service which is normally part of the log-collector infrastructure. As this is a large Java daemon with significant memory requirements, it is often useful to disable it for testing environments. Note that in this case one should also import *services.yml.no-elasticsearch* instead of the default *services.yml.default*.

`es_log_keep_days` is a dictionary that specifies the retention time for the various log types, in days. The default is `{ audit: 60, logstash: 15, http: 15 }`.

Monitoring

`alert_playbook_url` is the base URL for all the playbook links associated with the alerts.

`prometheus_tsdb_retention` controls the time horizon of the primary Prometheus instances (default 90d). Set it to a shorter value when enabling long-term storage mode.

`prometheus_lts_tsdb_retention` controls the time horizon of the long-term Prometheus instances (default 1 year), when they are enabled.

`prometheus_scrape_interval` sets how often the primary Prometheus instances should scrape their targets (default 10s).

`prometheus_lts_scrape_interval` sets how often the long-term Prometheus instances should scrape the primary ones (default 1m).

`prometheus_external_targets` allows adding additional targets to Prometheus beyond those that are described by the service metadata. It is a list of entries with *name* and *targets* attributes, where *targets* is also a list of host:port entries.

`prometheus_federated_targets` is a list of external Prometheus instances to scrape ("federate" in Prometheus lingo).

`alert_webhook_receivers` is a list of entries with *name* / *url* attributes representing escalation webhook URLs for the alertmanager, allowing alert delivery over non-email transports.

Third-party services

Private Docker registry

You can have float use a private Docker registry by providing it with the credentials for "docker login":

`docker_registry_url` - URL of the private Docker registry

`docker_registry_username` - username for "docker login"

`docker_registry_password` - password for "docker login"

Alert delivery

The float monitoring system requires an external email account to deliver its alerts over email. Alert delivery can be configured with the following variables:

`alert_email` - address that should receive email alerts

`alertmanager_smtp_from` - sender address to use for alert emails

`alertmanager_smtp_smarthost` - server to use for outbound SMTP

`alertmanager_smtp_require_tls` should be set to *true* if the server requires TLS

`alertmanager_smtp_auth_username` and `alertmanager_smtp_auth_password` - credentials for authentication

`alertmanager_smtp_hello` - hostname to use in the HELO SMTP header sent to the server (default *localhost*)

If *alert_email* is left empty, alertmanager won't deliver any alerts but it will still be active and functional (via *amtool*).

Backups

To configure the backup system, you're going to need credentials for an external repository. The backup system uses restic, so check its documentation for the URI syntax.

`backup_repository_uri` - URI of the global (shared) restic repository

`backup_repository_restic_password` - the password used to encrypt the restic repository.

Operations

Requirements

On the driver host

You're going to need a relatively recent version of Ansible (>= 2.7), and a few small other custom tools used to manage credentials, that you will build yourself. Float also requires a Python 3 interpreter, now that Python 2 is unsupported.

```
sudo apt install golang bind9utils ansible python3-six
go get git.autistici.org/ale/x509ca
go get git.autistici.org/ale/ed25519gen
export PATH=$PATH:$HOME/go/bin
```

NOTE: On Ubuntu, the *dnssec-keygen* command in bind9utils has been replaced by *tsig-keygen* from the bind9 package, so you're going to need to install the bind9 package instead of bind9utils.

NOTE: the Ansible version packaged with Debian buster (2.7.7) needs a patch if your service configuration includes MySQL instances, see the `ansible-buster.patch` file in the top-level directory for instructions.

On the target hosts

Float only supports targets running a Debian distribution (generally around the current *stable*). Furthermore, in order to run Ansible, both the *python* and *python-apt* packages need to be installed.

Float likes to think it "owns" the machines it's deployed on: it will assume it can modify the system-level configuration, install packages, start services, etc.

However, it assumes that certain functionality is present, either managed manually or with some external mechanism (your own Ansible roles, for instance):

- Network configuration must be externally managed, except for the network overlays explicitly configured in *float*.
- Partitions, file systems, LVs must be externally managed, with the exception of the volumes explicitly defined in your configuration, which will be created by *float* when necessary.
- SSH access and configuration must be externally managed **unless** you explicitly set *enable_ssh=true* (and add SSH keys to your admin users), in which case *float* will take over SSH configuration and you might need to modify your Ansible SSH configuration after the first run.

Float does not use, and does not modify, the hostname of the servers it manages: it only references the host names used in the inventory. Things will be less confusing if you ensure that the names match, but it is not a strict requirement.

Ansible Integration

The toolkit is implemented as a set of Ansible plugins and roles, meant to be integrated into your own Ansible configuration. The plugins are:

- *inventory/float.py*, which provides the core of the functionality: it parses the services descriptions, runs the scheduling algorithm, and creates a variety of pre-defined Ansible variables and artifacts for the roles to use;
- *actions/* plugins that perform credentials-related generation and signing in a standardized fashion: these are tasks with local and remote components that would otherwise be very verbose if expressed as Ansible tasks, so they have been made into modules instead;
- *vars/gpg_vars.py* which adds to Ansible the ability to read GPG-encrypted files (with a `.gpg` extension) from *vars* and *group_vars* subdirectory -- it is not used directly by float and it is provided just as a convenience.

There are many Ansible roles used by the float infrastructure, so they are loosely organized with their naming scheme in three major groups:

- *base* roles implement the necessary low-level functionality required by the infrastructure, setting up machines and preparing them to run containers, distributing the necessary credentials, setting up networking, etc.
- *infra* roles are meant to configure specific services that are part of the wider float cluster-level infrastructure but, with few exceptions, run *on top* of the float infrastructure itself provided by the *base* layer;
- *util* roles implement internal functionality and are generally meant to be included by other roles, or to handle common Ansible-related logic that does not fit elsewhere.

Setting up your Ansible environment

To use float, you will have to include it from your own Ansible configuration, and specify the inventory and service configuration in our own format.

There are some minimal requirements on how your Ansible environment should be set up for this to work:

- you must have a *group_vars/all* directory (this is where we'll write the autogenerated application credentials file *secrets.yml*q)
- you must include float's *playbooks/all.yml* playbook file from the toolkit source directory at the beginning of your playbook
- you should use the *float* wrapper instead of running *ansible-playbook* directly (it helps setting up the command line)

Float requires the usage of Ansible Vault for its application-level secrets file. This means that you *need* to set an ANSIBLE_VAULT_PASSWORD_FILE pointing at a file containing the ansible-vault passphrase. A useful feature to remember is that Ansible Vault will execute, not read, the ANSIBLE_VAULT_PASSWORD_FILE if it is executable, which allows you to set up an encrypted-at-rest self-decrypting passphrase file, e.g.:

```
$ (echo '#!/usr/bin/gpg -d'; gpg -a -e .ansible_vault_pw) \
    > .ansible_vault_pw.gpg
$ chmod +x .ansible_vault_pw.gpg
$ export ANSIBLE_VAULT_PASSWORD_FILE=.ansible_vault_pw.gpg
```

Your *ansible.cfg* configuration file must point at float's plugins and roles. Assuming the float source repository is stored in the `./float` directory (as it is common when using git submodules to import it), the following directives should be set:

```
[defaults]
roles_path = ./float/roles:./roles
inventory_plugins = ./float/plugins/inventory
action_plugins = ./float/plugins/action
vars_plugins = ./float/plugins/vars
force_handlers = True

[inventory]
enable_plugins = float
```

(the above will also look for your own roles in the `./roles` dir).

The *force_handlers* option is important because *float* controls system status via handlers, and they should run even in case of errors.

Variables

The float plugin sets a number of host variables and global configuration parameters that can be used by service-specific Ansible roles.

The following global variables are defined:

- `services` holds all the service metadata, in a dictionary indexed by service name;

Other variables are defined in *hostvars* and will be different on every host depending on the service assignments (note that `<service>` is a placeholder for the service name, where dashes have been replaced by underscores):

- `float_enable_<service>`, that evaluates to true on the hosts assigned to the service (note: dashes in the service name are converted to underscores)
- `float_instance_index_<service>` is the progressive index of the current instance of the service (0-based).
- `float_<service>_is_master` is true on the host where the master instance is scheduled, and false elsewhere. This variable is only defined for services using static master election (i.e. where *master_election* is true in the service metadata)
- `float_enabled_services` contains the list of enabled services on this host

- `float_disabled_services` contains the list of disabled services on this host
- `float_enabled_containers` contains a list of dictionaries describing the containers that should be active on this host. The dictionaries have the following attributes:
  - `service` is the service metadata
  - `container` is the container metadata

Groups

The scheduler also defines dynamic Ansible groups based on service assignments:

- For each service, it will define a host group named after the service, whose members are the hosts assigned to the service;
- for each network overlay defined in the inventory, it will define a host group named `overlay-<name>` whose members are the hosts included in that overlay.

These groups can then be used to assign service-specific roles to the scheduled hosts in the playbook:

```yaml
- hosts: myservice
  roles:
    - myservice
```

Or, for instance, to enumerate the hostnames of the service instances in a template:

```
{% for h in groups['myservice'] | sort %}
  {{ h }}.myservice.{{ domain }}
{% endfor %}
```

Float depends on the *frontend* group being defined by the user.

The *float* command-line tool

While it is perfectly possible to use *float* just as an Ansible "library", using your normal Ansible workflow and running *ansible-playbook*, we provide a simple command-line wrapper for convenience. This wrapper is also called *float*, and you can find it in the root directory of this repository. The tool also contains some useful functionality for generating configuration templates for your environments.

Since it is basically a wrapper for *ansible-playbook*, it only requires Python and Ansible to be installed and introduces no additional dependencies.

The *float* tool has a command-based syntax. The known commands are:

create-env

The *create-env* command generates a configuration template for a new *float* environment. You must pass it the path to a (new) directory where the configuration files will be written. Command-line flags control some details of the generated configuration:

- *--domain* defines the base domain for the environment. The default is *example.com*. The internal domain used for service discovery is derived from this value by prepending the *infra* component.
- *--vagrant* is a boolean flag that tells float to generate a Vagrantfile and an inventory file with a number of VMs controlled by the *--num-hosts* flag (by default 3).
- *--mitogen* is an optional flag that should point at a directory containing the Mitogen source repository. When this flag is specified, the generated *ansible.cfg* will include the Mitogen plugin, and it will specify the *mitogen_linear* strategy. We've found Mitogen to dramatically increase Ansible performance and we use it often, so this option saves from further editing of the *ansible.cfg* file.

There are many other options used to control specific parameters of the generated Vagrant configuration (including support for *libvirt* and other features), check out "float create-env --help" for more details.

You will most definitely need to edit the generated files.

run

The *run* command executes a playbook, and it's basically a wrapper to *ansible-playbook* that simplifies setting up the environment variables required for the *float* plugins to work. In practical terms, this means:

- auto-location of built-in playbooks: if the playbook path passed to *float run* does not exist, the tool will look for it in the playbooks directory of the float source repository, possibly adding the *.yml* extension if missing. This makes it possible to, for instance, invoke the docker built-in playbook simply by running:

```
/path/to/float/float run docker
```

The *run* command will read the float configuration from the *config.yml* file in the current directory by default. You can use the *--config* command-line flag to point it at a different configuration file.

Most *ansible-playbook* options are supported, though not all of them, including *--diff*, *--check*, and *--verbose*.

The above command is pretty much equivalent to:

```
ansible-playbook -i config.yml playbooks/docker.yml
```

so it is possible that, as functionality is removed from the wrapper, the *run* command might eventually disappear.

Built-in playbooks

You can invoke any valid Ansible playbook with "float run", but there are specific playbooks bundled with *float* that are meant to perform specific tasks:

- `init-credentials.yml` initializes the long-term credentials associated with a float environment, including application secrets from *passwords.yml*. This playbook must be run first, before any other float playbooks can run. It is not run as part of the default playbook, but it is kept separate because init-credentials is the only playbook that creates changes to your local repository.

- `apt-upgrade.yml` upgrades all packages and removes unused ones. This task is also not run (for the moment) as part of the default playbook, to grant explicit control on when package updates are run.

Testing

Float, like most similar systems, pushes you to split your configuration into two separate parts:

- a description of the services and their associated Ansible roles
- a list of target hosts and some global configuration variables

this second part is what is called an *environment*. It establishes the specific identity of an installation, and if things have been done properly (i.e. the service description does not have any hard-codec parameters that should be installation-specific) you can have many of them, each reproducing the full functionality.

This is so useful for testing purposes that float has functionality explicitly dedicated to support the quick creation of testing environments, that use tools like Vagrant to create virtual machines to use as installation targets.

Running float with Vagrant

The *create-env* command of the float command-line tool can be used to generate a Vagrant configuration file along with the float configuration skeleton, by passing it the *--vagrant* option.

There are additional command-line options available to set the desired number of hosts (*--num-hosts*) and their memory allocation (*--ram*). The resulting Vagrantfile will be tuned for the Virtualbox provider (default), but it can be tuned for libvirt instead if the *--libvirt* option is used. In this case, it is possible to use a remote libvirt instance (over SSH) by specifying *--libvirt=USER@HOST*, or to use the local one with *--libvirt=localhost*.

A note on remote libvirt setups: since float testing environments tend to be relatively resource- and bandwidth-intensive (we do not recommend running test VMs with less than 1-2 GBs of RAM, and there are a few GBs of packages to download), this has proven to be a robust solution to let administrators set up test environments even without requiring beefy hardware or network connections, but using instead the resources of some online server.

From that point on, running a testing environment involves simply:

```
$ vagrant up
$ float run init-credentials.yml
$ float run site.yml
```

Functionality available in testing environments

Some things in the float infrastructure are configured differently when *testing=true*, to facilitate debugging and inspection. These are also the reasons why you should **not** run a production (publicly accessible) environment with *testing* set to true.

- all logs are collected on the *log-collector* hosts in text format under */var/log/remote*, for easy inspection without having to go through Elasticsearch
- a SOCKS5 proxy is run on port 9051 on the first host of the *frontend* group, without authentication. This is so you can connect to the HTTP services offered by the test environment, using the DNS from the environment itself.
- the ACME automation will only generate self-signed certificates and it will not attempt to contact Letsencrypt servers

List of administrative web applications

These are all the available web interfaces in the default float service configuration. They are all protected by single sign-on. Here *domain* stands for your public domain:

- `https://admin.`*domain* - float main dashboard, lists all the configured services and their assigned hosts
- `https://logs.`*domain* - Kibana dashboard for exploring logs
- `https://grafana.`*domain* - Grafana monitoring dashboards
- `https://alerts.`*domain* - Summary of the currently firing alerts
- `https://monitor.`*domain* - Prometheus web interface, useful for manually exploring metrics
- `https://prober.`*domain* - Prometheus blackbox prober web UI

- `https://backups.`*domain* - Backup management dashboard

Common tasks

Rolling back the configuration

If you are using a Git repository as your configuration source, *float* will keep track of which commit has been pushed to production last, and it will try to prevent you from pushing an old version of the configuration, failing immediately with an error. This is a simple check to make sure that people do not inadvertently roll back the production configuration by pushing from an out-of-date client.

In most cases what you want to do in that case is to simply run *git pull* and bring your copy of the repository up to date. But if you really need to push an old version of the configuration in an emergency, you can do so by setting the *rollback* value to *true* on the command-line:

```
$ float run -e rollback=true site.yml
```

Adding an admin account

Adding a new administrator account is just a matter of editing the *admins* configuration variable and add a new entry to it.

The first thing you will need is a hashed version of your password. The authentication service in float supports a number of legacy hashing schemes, including those supported by the system crypt(). The most secure hashing scheme supported is Argon2, and you can use our custom tool to generate a valid hash. To install it:

```
$ go install git.autistici.org/ai3/go-common/cmd/pwtool
```

Run the *pwtool* utility with your new password as an argument, as shown below:

```
# Do not save your password in the history of your shell
$ export HISTIGNORE="./pwtool.amd64*"
$ ./pwtool.amd64 PASSWORD
```

where PASSWORD is your desired password.

It will output the hashed password.

Then modify the YAML file *group_vars/all/admins.yml*. At the bare minimum the new account should have a *name*, *email*, *password* and *ssh_keys* attributes, e.g.:

```yaml
---
admins:
  - name: "foo"
    email: "foo@example.com"
    password: "$a2$3$32768$4$abcdef...."
```

```
    ssh_keys:
      - "ssh-ed25519 AAAAC3Nza..."
```

Here above "ssh_keys:" needs to be populated with your public key, possibly stripped from the trailing user@hostname text (which may leak your personal information), and "password:" must be the hashed password you got from *pwtool* earlier.

Setting up OTP for an admin account

First you need to manually generate the OTP secret on your computer:

```
$ SECRET=$(dd if=/dev/urandom bs=20 count=1 2>/dev/null | base32)
$ echo $SECRET
EVUVNACTWRAIERATIZUQA6YQ4WS63RN2
```

Install the package qrencode, and feed the OTP secret to it. For example with apt ["apt install qrencode" of course].

```
$ EMAIL="sub@krutt.org"
$ qrencode -t UTF8 "otpauth://totp/example.com:${EMAIL}?secret=${SECRET}&issuer=example.com&
```

and read the qrcode with your favourite app.

Then add it to your user object in *group_vars/all/admins.yml* as the *totp_secret* attribute:

```
---
admins:
  - name: "foo"
    totp_secret: "EVUVNACTWRAIERATIZUQA6YQ4WS63RN2"
    ...
```

Finally, configure your TOTP client (app, YubiKey, etc.) with the same secret.

Note that the secret is stored in cleartext in the git repository, so using a hardware token (U2F) is preferred.

Registering a U2F hardware token for an admin account

In the *group_vars/all/admins.yml* file, you can add the *u2f_registrations* attribute to accounts, which is a list of the allowed U2F device registrations.

To register a new device, you are going to need the *pamu2fcfg* tool (part of the *pamu2fcfg* Debian package). The following snippet should produce the two YAML attributes that you need to set:

```
$ pamu2fcfg --nouser --appid https://accounts.example.com \
    | tr -d : \
    | awk -F, '{print "key_handle: \"" $1 "\"\npublic_key: \"" $2 "\""}'
```

press enter, touch the key, copy the output and insert it in *group_vars/all/admins.yml*, the final results should look like:

```yaml
---
admins:
  - name: "foo"
    email: "foo@example.com"
    password: "$a2$3$32768$4$abcdef...."
    ssh_keys:
      - "ssh-ed25519 AAAAC3Nza..."
    u2f_registrations:
      - key_handle: "r4wWRHgzJjl..."
        public_key: "04803e4aff4..."
```

NOTE: the above will work with *pam_u2f* version 1.0.7, but it will *not* work with pam_u2f version 1.1.0 due to changes in the output format!

Upgrading Debian version on target hosts

Float generally targets the current Debian *stable* distribution, but it uses explicit distribution names (*stretch*, *buster*, etc) to avoid unexpected dist-upgrades.

Whenever the Debian stable version changes, you should probably upgrade your servers too. There is support for this as a multi-step process:

- Set *float_debian_dist* to the new codename (e.g. "buster") in your group_vars/all configuration.
- Run *float*, which will install the correct APT sources for the new release.
- Run *apt dist-upgrade* manually or via Ansible. This part is not automated yet due to the large variety in possible scenarios.
- Run *float* again: it will now detect that the distribution has changed and reconfigure packages as needed.

Example scenarios

This section will look at some example scenarios and use cases for float, and will look into some possible configurations for them.

Simple HTTP application

The simplest possible scenario involves a stateless HTTP web application, which for convenience we will package as a single standalone container (no databases, data storage, or anything). Let's take as an example okserver, a simple and completely useless HTTP web application that will just respond "OK" to any request.

What we expect is to turn a few hosts we have into a robust platform for serving this web application, along with valid DNS records, certificates, all that is necessary.

The services.yml file will include the float default services, and it will add our own. We've randomly chosen port 3100 (which we know is available) for the service.

```yaml
include:
  - "/path/to/float/services.yml.default"
ok:
  scheduling_group: backend
  num_instances: 1
  containers:
    - name: http
      image: registry.git.autistici.org/ai3/docker/okserver:master
      port: 3100
      env:
        PORT: 3100
  public_endpoints:
    - name: ok
      port: 3100
      scheme: http
```

The container is fully configured via environment variables, so there is no need to create a corresponding Ansible role to create configuration files or any other setup steps.

The scenario is so simple that we can run it on a single host, so we can create an inventory file where our only hosts shares the *frontend* and *backend* groups:

```yaml
hosts:
  host1:
    ansible_host: 1.2.3.4
    ip: 1.2.3.4
    name: host1
    groups: [frontend, backend]
```

The same services.yml would automatically provide a highly-available architecture when scaled to multiple hosts with their separate frontend and backend groups.

A UDP service

Let's consider a scenario where the service that we want to offer is not HTTP- or TCP-based, for example a UDP-based videoconferencing app: here we'll have to do a bit more work, because float's reverse proxying architecture does not handle this case. Furthermore, in this case we do not want a reverse proxy architecture *at all*, because the resource that we need to manage is bandwidth.

A reasonable option would be to simply have another group of hosts that is neither *frontend* nor *backend*, but is dedicated to receiving (and scaling) this type of traffic specifically.

So our inventory could look like:

```
hosts:
  host1:
    ansible_host: 1.2.3.4
    ip: 1.2.3.4
    name: host1
    groups: [frontend, backend]
  host2:
    ansible_host: 2.3.4.5
    ip: 2.3.4.5
    name: host1
    groups: [videoconf]
```

Note that there is no need for it to be separate from frontend/backend, it's just to show that the group can be scaled independently.

The services.yml file:

```
include:
  - "/path/to/float/services.yml.default"
videoconf:
  scheduling_group: videoconf
  num_instances: all
  containers:
    - name: http
      image: video.conf.container:stable
      port: 3200
      env:
        PORT: 3200
```

The lack of any public endpoint in the *videoconf* service specification has a few consequences:

- float won't generate an HTTP config (fine, we don't need it) nor a DNS configuration for this service, and we need this one in order to send users to the right servers;
- no firewall rules will be generated automatically.

We're going to have to address these issues with custom Ansible roles. We're going to need two of them: one to be run on the *frontend* hosts, to customize the DNS configuration, and one on the *videoconf* hosts to fix the firewall configuration.

roles/videoconf/tasks/main.yml

```
- name: Set up firewall
  copy:
    dest: /etc/firewall/filter.d/99videoconf
```

```
    content: |
      add_port udp 3200
```

roles/videoconf-frontend/tasks/main.yml

```
- name: Set up DNS for videoconf
  template:
    dest: /etc/dns/videoconf.yml
    src: dns.yml.j2
```

roles/videoconf-frontend/templates/dns.yml.j2

```
videoconf.{{ domain_public[0] }}:
{% for host in groups['videoconf'] | sort %}
  - A {{ hostvars[host].public_ip | default(hostvars[host].ip) }}
{% endfor %}
```

this will point videoconf.my.domain to the hosts in the *videoconf* group (using their *public_ip* host attribute, if defined, or falling back to *ip*).

playbook.yml

```
- hosts: frontend
  roles:
    - videoconf-frontend
- hosts: videoconf
  roles:
    - videoconf
```