locationd Documentation

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Canonical Ltd.

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CHAPTER 1

Introduction

locationd is a central hub for multiplexing access to positioning subsystems available via hard- and software. It provides a client API offering positioning capabilities to applications and other system components, abstracting away the details of individual positioning solutions.

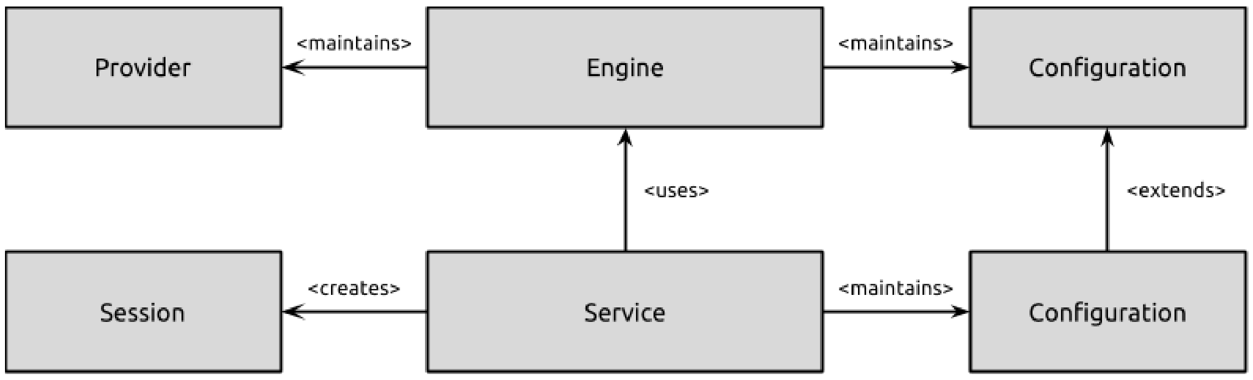
Vocabulary

To make the remainder of this documentation as easily understandable as possible, we start over with introducing some vocabulary:

- `Engine`: Responsible for handling input from multiple positioning subsystems and maintaining the state of the overall system. Think about it like the heart of the system.
- `Provider`: A positioning subsystem that feeds into the positioning engine. Common examples are a GPS provider or a network-based positioning provider.
- `Service`: The point of entry for applications and services that would like to receive position data.
- `Session`: In order to receive position information, every application or service has to create a session with the location Service. Session creation is subject to security mediation and contextual prompting.
- `Update`: An update is a timestamped entity to a certain type of data.
- WGS84: The coordinate system that is used throughout the entire location subsystem.

Architectural Overview

The high-level architecture of the service is shown in the following diagram:



In this diagram, the configuration of the engine refers to:

- The current state of any satellite-based positioning subsystems. Can either be off or on.
- The current state of reporting facilities responsible for harvesting wifi and cell id measurements together with location information and sending them off to remote services. Can either be off or on.
- The overall state of the engine. Can either be off, on or active.

The Service takes this configuration and exposes it to client applications. In addition, mainly for debugging purposes, the set of currently visible satellites (if any) is maintained and exposed to privileged client applications. The service supports multiple different satellite-based positioning operating in parallel. The following GNSSs are known:

- Beidou: People's Republic of China's regional system, currently limited to Asia and the West Pacific.
- Galileo: A global system being developed by the European Union and other partner countries, planned to be operational by 2014 (and fully deployed by 2019).
- Glonass: Russia's global navigation system. Fully operational worldwide.
- GPS: Fully operational worldwide.
- Compass: People's Republic of China's global system, planned to be operational by 2020.
- IRNSS: India's regional navigation system, planned to be operational by 2014, covering India and Northern Indian Ocean.
- QZSS: Japanese regional system covering Asia and Oceania.

Privacy & Access Control

Location information is highly privacy relevant. For this reason, the locationd is deeply integrated with AppArmor and Ubuntu's overall trust infrastructure. Every incoming session request is validated and if in doubt, the user is asked to explicitly grant trust to the application requesting access to positioning information. Please see [@ref com::ubuntu::location::service::PermissionManager] for further details.

In addition, the locationd allows for selectively adjusting the accuracy and reporting setup of the location Engine to provide further fine-grained control over the exposed data to user. Within this setup, a user is able to entirely disable all positioning.

CHAPTER 2

CLI

locationd offers a command-line interface for controlling and monitoring the service. The following commands are available:

- `list`: Lists all provider implementations known to the service.
- `monitor`: Connects to a locationd instance, monitoring its activity. Supports KML or tabular data output of position/heading/velocity data.
- `provider`: Executes a known provider implementation in an out-of-process sandbox.
- `run`: Executes the service.
- `set`: Persist the given key/value pair.
- `status`: Queries the status of a service instance.
- `test`: Executes standalone runtime tests against individual provider implementations.

For all of the commands, an exit status of 0 indicates success. An exit status of 1 indicates an error. Normal output goes to stdout, while all errors/warnings are output to stderr.

Snap-Specific Command Names

If you are using the cli from a snap (`snap install locationd --channel edge`), the commands will be wrapped up for you in a convenient way, following the pattern locationd.$COMMAND. With that, if you want to check on the status of the service, simply run:

```
$ locationd.status
```

Hotplug Support

locationd itself does not interface with udev directly but instead delegates to the host system's udev setup and the user/administrator to define reasonable udev rules.

Testing Scenarios

For testing purposes, it is often handy to inspect position/velocity/heading estimates on the command line. The `monitor` command helps here. It connects to the service, starts the positioning engine and outputs position estimates to stdout until it receives a SIGTERM.

```
$ locationd.monitor
I0516 08:36:56.752629  8124 monitor.cpp:226] Enabled position/heading/velocity␣
↪updates...
51.44483       7.21064        13.27          n/a            n/a            n/a          ␣
↪     n/a
51.44483       7.21064        13.26          n/a            n/a            n/a          ␣
↪     n/a
51.44483       7.21069        16.36          n/a            n/a            n/a          ␣
↪     n/a
51.44483       7.21069        16.36          n/a            n/a            n/a          ␣
↪     n/a
51.44483       7.21068        15.94          n/a            n/a            n/a          ␣
↪     n/a
51.44483       7.21064        12.66          n/a            n/a            n/a          ␣
↪     n/a
51.44484       7.21063        12.26          n/a            n/a            n/a          ␣
↪     n/a
51.44484       7.21063        12.26          n/a            n/a            n/a          ␣
↪     n/a
51.44485       7.21059        10.00          n/a            n/a            n/a          ␣
↪     n/a
51.44485       7.21059        10.00          n/a            n/a            n/a          ␣
↪     n/a
51.44485       7.21058        10.08          n/a            n/a            n/a          ␣
↪     n/a
51.44485       7.21058        10.08          n/a            n/a            n/a          ␣
↪     n/a
51.44485       7.21059        10.00          n/a            n/a            n/a          ␣
↪     n/a
51.44485       7.21059        10.00          n/a            n/a            n/a          ␣
↪     n/a
51.44485       7.21059        10.00          n/a            n/a            n/a          ␣
↪     n/a
51.44485       7.21059        10.00          n/a            n/a            n/a          ␣
↪     n/a
```

Standalone Runtime Tests

Sometimes it is convenient to be able to test specific provider implementations in isolation, i.e., without the respective provider running in the context of locationd. To this end, the `test` command is available. Right now, two test suites `sirf` and `ubx` are available. Please make sure that the underlying serial devices are not in use by any other process before executing the test suite. The behavior of the test-suites can be adjusted by the following environment variables:

- `ubx`:
  - `UBX_PROVIDER_TEST_DEVICE`: Mandatory, path to the serial device connecting to the uBlox receiver.
  - `UBX_PROVIDER_TEST_TRIALS`: Defaults to 15, number of independent positioning attempts from cold start.

  - UBX_PROVIDER_TEST_ASSIST_NOW_ENABLE: Defaults to false, toggles usage of uBlox Assist-Now Online for assisted GNSS.
  - UBX_PROVIDER_TEST_ASSIST_NOW_TOKEN: Defaults to the empty string, token used to verify access to the uBlox AssistNow services.
  - UBX_PROVIDER_TEST_ASSIST_NOW_ACQUISITION_TIMEOUT: Defaults to 5 seconds, the provider waits this long for an initial fix before reaching out for assistance data.
- sirf:
  - SIRF_PROVIDER_TEST_DEVICE: Mandatory, path to the serial device connecting to the SiRF receiver.
  - SIRF_PROVIDER_TEST_TRIALS: Defaults to 15, number of independent positioning attempts from cold start.

An example invocation for testing the uBlox provider would look like:

```
$ sudo UBX_PROVIDER_TEST_DEVICE=/dev/ttyACM1 UBX_PROVIDER_TEST_TRIALS=50 locationd.
↪test --test-suite=ubx
```

Verbose Logging

locationd and all of its commands can be switched to verbose mode by setting the environment variable GLOG_v to 1, e.g.:

```
$ sudo GLOG_v=1 locationd.provide --id=mls::Provider
I0516 08:40:15.010741  8200 service.cpp:190] static void␣
↪location::dbus::stub::Service::on_bus_acquired(GObject*, GAsyncResult*, gpointer)
I0516 08:40:15.015348  8200 service.cpp:221] static void␣
↪location::dbus::stub::Service::on_name_appeared_for_creation(GDBusConnection*,␣
↪const gchar*, const gchar*, gpointer)
I0516 08:40:15.022554  8200 service.cpp:165] static void␣
↪location::dbus::stub::Service::on_proxy_ready(GObject*, GAsyncResult*, gpointer)
I0516 08:40:15.029153  8200 w11t_manager.cpp:452] static void␣
↪location::connectivity::w11t::Supplicant::on_bus_ready(GObject*, GAsyncResult*,␣
↪gpointer)
I0516 08:40:15.033778  8200 service.cpp:244] static void␣
↪location::dbus::stub::Service::on_provider_added(GObject*, GAsyncResult*, gpointer)
I0516 08:40:15.034494  8200 w11t_manager.cpp:477] static void␣
↪location::connectivity::w11t::Supplicant::on_proxy_ready(GObject*, GAsyncResult*,␣
↪gpointer)
I0516 08:40:15.036355  8200 w11t_manager.cpp:285] static void␣
↪location::connectivity::w11t::Interface::on_proxy_ready(GObject*, GAsyncResult*,␣
↪gpointer)
I0516 08:40:21.915056  8200 provider.cpp:467] static bool␣
↪location::providers::remote::Provider::Skeleton::handle_
↪activate(ComUbuntuLocationServiceProvider*, GDBusMethodInvocation*, gpointer)
I0516 08:40:26.832139  8200 w11t_manager.cpp:310] static void␣
↪location::connectivity::w11t::Interface::handle_scan_
↪done(FiW1Wpasupplicant1WirelessInterface*, gboolean, gpointer)
I0516 08:40:26.832207  8200 provider.cpp:91] Wireless network scan finished.
I0516 08:40:33.293536  8200 w11t_manager.cpp:325] static void␣
↪location::connectivity::w11t::Interface::handle_bss_
↪added(FiW1Wpasupplicant1WirelessInterface*, const char*, GVariant*, gpointer)
I0516 08:40:33.294180  8200 w11t_manager.cpp:310] static void␣
↪location::connectivity::w11t::Interface::handle_scan_
↪done(FiW1Wpasupplicant1WirelessInterface*, gboolean, gpointer)
```

```
I0516 08:40:33.294219  8200 provider.cpp:91] Wireless network scan finished.
I0516 08:40:33.297814  8200 w11t_manager.cpp:98] static void␣
↪location::connectivity::w11t::BSS::on_proxy_ready(GObject*, GAsyncResult*, gpointer)
I0516 08:40:43.278961  8200 w11t_manager.cpp:354] static void␣
↪location::connectivity::w11t::Interface::handle_bss_
↪removed(FiW1Wpasupplicant1WirelessInterface*, const char*, gpointer)
I0516 08:40:43.279033  8200 w11t_manager.cpp:310] static void␣
↪location::connectivity::w11t::Interface::handle_scan_
↪done(FiW1Wpasupplicant1WirelessInterface*, gboolean, gpointer)
I0516 08:40:43.279059  8200 provider.cpp:91] Wireless network scan finished.
I0516 08:40:43.284925  8200 w11t_manager.cpp:169] static void␣
↪location::connectivity::w11t::BSS::on_age_changed(GObject*, GParamSpec*, gpointer)
```

CHAPTER 3

API

Locationd offers multiple different ways of interfacing with the service. The primary protocol is using DBus. We offer a plain C++ API, too, that abstracts away the protocol details.

All APIs we expose are guaranteed to remain ABI stable within any given major release.

DBus

The DBus introspection files are available in `${SOURCE}/data/location/dbus` ready for consumption by static and dynamic binding generators. Methods, properties and signals are documented within the respective introspection files.

C++

A client application then uses the API to establish a session with a service, register observers to receive updates and to control the status of updates. The following snippet illustrates basic usage of the client API:

```
#include <location/service.h>
#include <location/session.h>

#include <location/glib/context.h>

auto context = location::glib::Context::create_for_system_bus();

context->connect_to_service([context](const location::Service::Ptr& service)
{
    service->create_session_for_criteria(location::Criteria{}, [context,␣
↪service](const location::Session::Ptr& session)
    {
        session->updates().position.changed().connect([this](const location::Update
↪<location::Position>& pos)
        {
            std::cout << pos << std::endl;
        });

        session->updates().heading.changed().connect([this](const location::Update
↪<location::units::Degrees>& heading)
        {
            std::cout << pos << std::endl;
        });

        session->updates().velocity.changed().connect([this](const location::Update
↪<location::units::MetersPerSecond>& velocity)
        {
            std::cout << pos << std::endl;
        });

        session->updates().position_status =␣
↪location::Service::Session::Updates::Status::enabled;
        session->updates().heading_status =␣
↪location::Service::Session::Updates::Status::enabled;
        session->updates().velocity_status =␣
↪location::Service::Session::Updates::Status::enabled;
    });
});
```

CHAPTER 4

Hacking

Building the code

By default, the code is built in release mode. To build a debug version, use

```
$ mkdir builddebug
$ cd builddebug
$ cmake -DCMAKE_BUILD_TYPE=debug ..
$ make
```

For a release version, use -DCMAKE_BUILD_TYPE=release

Running the tests

```
$ make
$ make test
```

Note that "make test" alone is dangerous because it does not rebuild any tests if either the library or the test files themselves need rebuilding. It's not possible to fix this with cmake because cmake cannot add build dependencies to built-in targets. To make sure that everything is up-to-date, run "make" before running "make test"!

Coverage

To build with the flags for coverage testing enabled and get coverage:

```
$ mkdir buildcoverage
$ cd buildcoverage
$ cmake -DCMAKE_BUILD_TYPE=coverage
$ make
$ make test
$ make coverage
```

Unfortunately, it is not possible to get 100% coverage for some files, mainly due to gcc's generation of two destructors for dynamic and non- dynamic instances. For abstract base classes and for classes that prevent stack and static allocation, this causes one of the destructors to be reported as uncovered.

There are also issues with some functions in header files that are incorrectly reported as uncovered due to inlining, as well as the impossibility of covering defensive assert(false) statements, such as an assert in the default branch of a switch, where the switch is meant to handle all possible cases explicitly.

If you run a binary and get lots of warnings about a "merge mismatch for summaries", this is caused by having made changes to the source that add or remove code that was previously run, so the new coverage output cannot sensibly be merged into the old coverage output. You can get rid of this problem by running

```
$ make clean-coverage
```

This deletes all the .gcda files, allowing the merge to (sometimes) succeed again. If this doesn't work either, the only remedy is to do a clean build.

If lcov complains about unrecognized lines involving '=====', you can patch geninfo and gcovr as explained here:

https://bugs.launchpad.net/gcovr/+bug/1086695/comments/2

Code style

We use a format tool that fixes a whole lot of issues regarding code style. The formatting changes made by the tool are generally sensible (even though they may not be your personal preference in all cases). If there is a case where the formatting really messes things up, consider re-arranging the code to avoid the problem. The convenience of running the entire code base through the pretty-printer far outweighs any minor glitches with pretty printing, and it means that we get consistent code style for free, rather than endlessly having to watch out for formatting issues during code reviews.

As of clang-format-3.7, you can use

```
// clang-format off
void    unformatted_code  ;
// clang-format on
```

to suppress formatting for a section of code.

To format specific files:

```
${CMAKE_BINARY_DIR}/tools/formatcode x.cpp x.h
```

If no arguments are provided, formatcode reads stdin and writes stdout, so you can easily pipe code into the tool from within an editor. For example, to reformat the entire file in vi (assuming ${CMAKE_BINARY_DIR}/tools is in your PATH):

```
1G!Gformatcode
```

To re-format all source and header files in the tree:

```
$ make formatcode
```

Thread and address sanitizer

Set SANITIZER to "thread" or "address" to build with the corresponding sanitizer enabled.

Updating symbols file

To easily spot new/removed/changed symbols in the library, the debian package maintains a .symbols file that lists all exported symbols present in the library .so. If you add new public symbols to the library, it's necessary to refresh the symbols file, otherwise the package will fail to build. The easiest way to do that is using bzr-builddeb:

```
$ bzr bd -- -us -uc -j8  # Don't sign source package or changes file, 8 compiles in␣
↪parallel
$ # this will exit with an error if symbols file isn't up-to-date
$ cd ../build-area/location-service-[version]
$ ./obj-[arch]/tools/symbol_diff
```

This creates a diff of the symbols in /tmp/symbols.diff. (The demangled symbols from the debian build are in ./new_symbols.)

Review any changes in /tmp/symbols.diff. If they are OK:

```
$ cd -
$ patch -p0 < /tmp/symbols.diff
```

ABI compliance test

To use this, install abi-compliance-checker package from the archives.

You can use abi-compliance-checker to test whether a particular build is ABI compatible with another build. The tool does some source-level analysis in addition to checking library symbols, so it catches things that are potentially dangerous, but won't be picked up by just looking at the symbol table.

Assume you have built devel in src/devel, and you have a later build in src/mybranch and want to check that mybranch is still compatible. To run the compliance test:

```
$ cd src
$ abi-compliance-checker -lib libunity-scopes.so -old devel/build/test/abi-compliance/
↪abi.xml -new mybranch/build/test/abi-compliance/abi.xml
```

The script will take about two minutes to run. Now point your browser at

```
src/compat_reports/libunity-scopes.so/[version]_to_[version]/compat_report.html
```

The report provides a nicely layed-out page with all the details.

CHAPTER 5

Indices and tables

- genindex
- modindex
- search