Connectivity documentation
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10 Writing ConnMan plugins
11 The plugin documentation in ConnMan was improved and submitted upstream.
12 The documentation about writing plugins can be found on ConnMan sources in the following files: doc/plugin-api.txt, src/device.c and src/network.c. Example plugins are plugins/bluetooth.c plugins/wifi.c, plugins/ofono.c, among others.

15 Customs ConnMan Session policies
16 The documentation to create Session policies files for specifics users and/or groups can be found in ConnMan sources doc/session-policy-format.txt. The policies files shall be placed in STORAGEDIR/session_policy_local directory, where STORAGEDIR by default points to /var/lib/connman. ConnMan can recognize changes to this directory during runtime and update Session policies accordingly.

21 Management of ConnMan Sessions
22 ConnMan provides a extensive API to manage the creation, configuration and removal of a session, doc/manager-api.txt details how to create and destroy a Session through the CreateSession() and DestroySession() methods. doc/session-api.txt details how to use a Session. Through this API an application can ask ConnMan to Connect/Disconnect a Session or change its settings. The Settings can also be changed by writing policies files as described in the previous topic.
23 The application requesting a Session needs to implement a Notification API to receive updates in the Session settings, such as when a Session becomes online. This is done via the Update() method.
24 See also doc/session-overview.txt.
25 The difference between using the Session API and the policy files in /var/lib/connman is that policy files can set policies to many sessions at the same time, based on user/group ID or SELINUX rules while Session API only changes one session at a time.
**WiFi radio start up behavior on ConnMan**

At the very first run ConnMan has the WiFi radio disabled by default, however sometimes it is important to have the radio enabled even in the first ConnMan run. To achieve this behavior ConnMan can be configured to enable the radio on it first run.

The file STORAGEDIR/settings, where STORAGEDIR by default points to /var/lib/connman, shall be edited, or even created, to have the following content:

```
[WiFi]
Enable=true
```

This configuration will tell ConnMan at start up to enable the WiFi radio.

**Supporting new data modems in oFono**

oFono has a great support for most of the modems out there in the market, however some new modem may not work out-of-the-box, in this case we need to fix oFono to recognize and handle the new modem properly. There are a couple of different causes why a modem does not work with oFono. In this section we will detail them and show how oFono can be fixed.

- Modem match failure: if the udevng plugin in oFono fails to match the new modem its code needs to be fixed to recognize the new modem. This kind of failure can be recognized by looking at the debug output of the udevng plugin (debug output is enabled when running ofonod with the `-d` option). If udevng doesn’t say anything about the new modem then it needs proper code to handle it. You can find an example on how to edit plugins/udevng.c to support a new modem in oFono git\(^1\). The oFono git history has many examples of patches to add support to new modems in plugins/udevng.c

- Some other modems does not implement the specifications properly and thus oFono needs to implement ‘quirks’ to have these modems working properly. Many examples of fixes can be found on oFono git:

  - https://git.kernel.org/cgit/network/ofono/ofono.git/commit/?id=d1ac1ba3d474e56593ac3207d335a4de3d1f4a1d
  - https://git.kernel.org/cgit/network/ofono/ofono.git/commit/?id=535f69dedd2fa292c7047620dc11336dfb480a0d

It is difficult to foresee the problems that can happen when trying a new modem due to the extensive number of commands and specifications oFono implements.

\(^1\)https://git.kernel.org/cgit/network/ofono/ofono.git/commit/?id=4cabledadfe241706e342720a20bdfec828d6f6d
Asking the [2]oFono community could be very helpful to solve any issue with a new modem.

**Writing new Telepathy Connection Managers**

New connection managers are implemented as separated component and have their own process. Telepathy defines the D-Bus interfaces [3] that each Connection Manager (CM) needs to implement. This is known as the Telepathy Specification.

The Connection Managers need to expose a bus name in D-Bus that begins with `org.freedesktop.Telepathy.ConnectionManager`, for example, the telepathy-gabble CM, has the `org.freedesktop.Telepathy.ConnectionManager.gabble` bus name to provide its XMPP protocol interfaces.

A client that wants to talk to the available Connection Managers in the D-Bus Session bus needs to call D-Bus `ListActivatableNames` method and search for names with the returned prefix.

The most important Interfaces that a Connection Manager needs to implement are `ConnectionManager`, `Connection` and `Channel`. The `ConnectionManager` handles creation and destruction of `Connection` object. A `Connection` object represents a connected protocol session, such as a XMPP session. Within a `Connection` many `Channel` objects can be created; they are used for communication between the application and the server providing the protocol service. A `Channel` can represent many different types of communications such as files transfers, incoming and outgoing messages, contact search, etc.

Another important concept is the [4]Handle. It is basically a numeric ID to represent various protocol resources, such as contacts, chatrooms, contact lists and user-defined groups.

The [5]Telepathy Developer’s Manual details how to use the Telepathy API and thus gives many suggestions of how those should be implemented by a new Connection Manager.

Studying the code of existing Connection Managers is informative when implementing a new one. Two good examples are telepathy-gabble [6] for the XMPP protocol or telepathy-rakia [7] for the SIP implementation.

Those Connection Managers use [8]Telepathy-GLib as a framework to implement the Telepathy Specification. The Telepathy-GLib repository has a few exam-

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2 https://ofono.org/community
3 http://telepathy.freedesktop.org/spec/
5 http://telepathy.freedesktop.org/doc/book/
6 http://cgit.freedesktop.org/telepathy/telepathy-gabble/
7 http://cgit.freedesktop.org/telepathy/telepathy-rakia/
8 http://cgit.freedesktop.org/telepathy/telepathy-glib/
It is strongly recommend to use Telepathy-GLib when implementing any new
connection manager. The Telepathy-GLib service-side API is only available in
C, but can also be access from other languages that can embed C, such as C++.
This library is fully documented.

Looking inside the telepathy-rakia code

To start, a small design document can be found at docs/design.txt in telepathy-
raokia sources. However, some parts of it are outdated.

Source files

- src/telepathy-rakia.c: this is the starting point of telepathy-rakia as it
  instantiates its ConnectionManager.
- src/sip-connection-manager.[ch]: defines the ConnectionManagerClass
  and requests the creation of a Protocol of type TpBaseProtocol.
- src/protocol.[ch]: defines the RakiaProtocolClass which creates the Tp-
  BaseProtocol object. The protocol is responsible for starting new Con-
  nections. The request arrives via D-Bus and arrives here through Telepathy-
  GLib.
- src/sip-connection.c: defines the RakiaConnectionClass which inherits
  from RakiaBaseConnectionClass. The latter inherits from TpBaseCon-
  nectionClass.
- src/sip-connection-helpers.[ch]: helper routines used by RakiaConnection
- src/sip-connection-private.h: private structures for RakiaConnection
- src/write-mgr-file.c: utility to produce manager files
- rakia/base-connection.[ch]: base class for RakiaConnectionClass. It imple-
  ments its parent, RakiaBaseConnectionClass
- rakia/base-connection-sofia.[ch]: Implements a callback to handle events
  from the SIP stack.
- rakia/text-manager.[ch]: defines RakiaTextManagerClass, to manage the
  RakiaTextChannel.
- rakia/text-channel.[ch]: defines RakiaTextChannelClass. This is a Telepa-
  thy Channel.
- rakia/media-manager.[ch]: defines RakiaMediaManagerClass. Handles
  the RakiaSipSession.

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9http://cgit.freedesktop.org/telepathy/telepathy-glib/tree/examples/README
10http://telepathy.freedesktop.org/doc/telepathy-glib/
• `rakia/sip-session.[ch]`: defines `RakiaSipSessionClass`; it relates directly to the definition of Session in the SIP specification.

• `rakia/call-channel.[ch]`: defines `RakiaCallChannelClass`. The object is created when an incoming call arrives or an outgoing call is placed. A `RakiaCallChannel` belongs to one `RakiaSipSession`.

• `rakia/sip-media.[ch]`: defines `RakiaSipMediaClass`. It is created immediately after a `RakiaCallChannel` is created. Can represent audio or video content.

• `rakia/call-content.[ch]`: defines `RakiaCallContentClass`. The object is created for each new medium added. It relates directly to the `Content` definition in the Telepathy specification. It could be an audio or video `Content`, it is matched one-to-one with a `RakiaSipMedia` object.

• `rakia/call-stream.[ch]`: defines the `RakiaCallStreamClass`. It could be an audio or video object. The object is created by `RakiaCallContent`.

• `rakia/codec-param-formats.[ch]`: helper to setting codecs parameters.

• `rakia/connection-aliasing.[ch]`: defines function for aliasing Connections.

• `rakia/debug.[ch]`: debug helpers

• `rakia/event-target.[ch]`: helper to listen for events for a NUA handle (see NUA definition in sofia-sip documentation).

• `rakia/handles.[ch]`: helpers for Handles.

• `rakia/sofia-decls.h`: some extra declaration

• `rakia/util.[ch]`: utility functions.

**sofia-sip**

sofia-sip\(^{11}\) is a User-Agent library that implements the SIP protocol as described in IETF RFC 3261. It can be used for VoIP, IM, and many other real-time and person-to-person communication services. telepathy-rakia makes use of sofia-sip to implement SIP support into telepathy. sofia-sip has good documentation\(^{12}\) on all concepts, events and APIs.

**Connection Manager and creating connections**

`src/telepathy-rakia.c` is the starting point of this Telepathy SIP service. Its `main()` function does some of the initial setup, including D-Bus and Logging and calls Telepathy-GLib’s `tp_run_connection_manager()` method. The callback passed to this method gets called and constructs a new Telepathy `ConnectionManager` GOobject. The Connection Manager Factory is at `src/sip-connection-manager.c`.

\(^{11}\)http://sofia-sip.sourceforge.net/

\(^{12}\)http://sofia-sip.sourceforge.net/refdocs/nua/
Once the Connection Manager Object construction is finalized, the creation of a SIP Protocol Object is triggered inside `rakia_connection_manager_constructed()` by calling `rakia_protocol_new()`. This function is defined in `src/protocol.c`. It creates a Protocol Object and adds the necessary infrastructure that a Connection Manager needs to manage the Protocol. In the Class Factory it is possible to see which methods are defined by this Class by looking at the `TpBaseProtocolClass base_class var:

```c
base_class->get_parameters = get_parameters;
base_class->new_connection = new_connection;
base_class->normalize_contact = normalize_contact;
base_class->identify_account = identify_account;
base_class->get_interfaces = get_interfaces;
base_class->dup_connection_details = get_connection_details;
base_class->dup_authentication_types = dup_authentication_types;
```

Documentation on each method of this class can be found in the Telepathy-GLib documentation for [TpBaseConnectionManager](http://telepathy.freedesktop.org/doc/telepathy-glib/TpBaseConnectionManager.html) and [TpBaseProtocol](http://telepathy.freedesktop.org/doc/telepathy-glib/telepathy-glib-base-protocol.html). The Protocol is bound to `ConnectionManager` through the method `tp_base_connection_manager_add_protocol()`.

The `new_connection()` method defined there is used to create a new Telepathy Connection when the `NewConnection()` method on `org.freedesktop.Telepathy.ConnectionManager.rakia` is called.

The Telepathy `Connection` object is of type `RakiaConnection`, which inherits from `RakiaBaseConnection`, which in turn inherits from `TpBaseConnection`. The methods used by `RakiaConnection` can be seen at the `RakiaConnectionClass` and `RakiaBaseConnectionClass` initializations. They are defined at `src/sip-connection.c` for the `RakiaBaseConnectionClass:

```c
sip_class->create_handle = rakia_connection_create_nua_handle;
sip_class->add_auth_handler = rakia_connection_add_auth_handler;
```

and for the `TpBaseConnectionClass:

```c
base_class->create_handle_repos = rakia_create_handle_repos;
base_class->get_unique_connection_name = rakia_connection_unique_name;
base_class->create_channel_managers = rakia_connection_create_channel_managers;
base_class->create_channel_factories = NULL;
base_class->disconnected = rakia_connection_disconnected;
base_class->start_connecting = rakia_connection_start_connecting;
base_class->shut_down = rakia_connection_shut_down;
base_class->interfaces_always_present =
```

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13http://telepathy.freedesktop.org/doc/telepathy-glib/TpBaseConnectionManager.html
During the `TpBaseConnection` object construction the `create_channel_managers` method is called. A `Channel` is an entity provided by a `Connection` to allow the communication between the local `ConnectionManager` and the remote server providing the service. A `Channel` can represent an incoming or outgoing IM message, a file transfer, a video call, etc. Many `Channels` can exist at a given time.

**Channels and Calls**

telepathy-rakia has two types of `Channels`: `Text` and `Call`. For `TextChannels` a `RakiaTextManager` objects is created. It inherits from `TpChannelManager`. `TpChannelManager` is a generic type used by all types of `Channels`. See `rakia/text-manager.c` for the `RakiaTextManagerClass` definitions. When constructed, in `rakia_text_manager_constructed()` the object sets the `connection_status_changed_cb` callback to get notified about `Connection` status changes. If the `Connection` status changes to `Connected`, the callback is activated and the code sets yet another callback, `rakia_nua_i_message_cb`. This callback is connected to `nua-event` from sofia-sip. This callback is responsible for managing an incoming message request from the remote server.

The callback then handles the message it receives through the `Connection` using the sofia-sip library. At the end of the function the following code can be found:

```c
channel = rakia_text_manager_lookup_channel (fac, handle);
if (!channel)
  channel = rakia_text_manager_new_channel (fac, handle, handle, NULL);
rakia_text_channel_receive (channel, sip, handle, text, len);
```

The RakiaTextManager tries to figure if an existing `Channel` for this message already exists, or if a new one needs to be created. Once the channel is found or created, RakiaTextManager is notified of the received message through `rakia_text_channel_receive()` which creates a `TpMessage` to wrap the received message.

A similar process happens with the similar `RakiaMediaManager` which handles SIP `Sessions` and `Call Channels`. The callback registered by `RakiaMediaManager` is `rakia_nua_iinvite_cb()`, in `rakia/media-manager.c`, it then can get notified of incoming invites to create a SIP `Session`. Once the callback is activated, which means when an incoming request to create a SIP `Session` arrives, a new `RakiaSipSession` is created. Outgoing requests to create a SIP session `RakiaSipSession` are initiated on the telepathy-rakia side through the exposed D-Bus interface. The request comes from the `TpChannelManager` object and is created by `rakia_media_manager_requestotron()` in the end of its call chain:

```c
static void
channel_manager_iface_init (gpointer g_iface, gpointer iface_data)
{
  TpChannelManagerIface *iface = g_iface;
```
iface->foreach_channel = rakia_media_manager_foreach_channel;
iface->type_foreach_channel_class = rakia_media_manager_type_foreach_channel_class;
iface->request_channel = rakia_media_manager_request_channel;
iface->create_channel = rakia_media_manager_create_channel;
iface->ensure_channel = rakia_media_manager_ensure_channel;

Here in channel_manager_iface_init(), telepathy-rakia sets which method it wants to be called when the D-Bus methods exposed by Telepathy-GLib are called. These functions handle Channel creation; however, they must first create a SIP Session before creating the Channel itself. The RakiaSipSession object will handle the Channels between the remote server and telepathy-rakia.

In the incoming path besides of creating a new SIP session the rakia_nua_i_invite_cb callback also sets a new callback incoming_call_cb, that as it name says get called when a new call arrives.

CallChannels, implemented as RakiaCallChannel in telepathy-rakia, are then created once this callback is activated or, for outgoing call channels requests, just after the RakiaSipSession is created. See the calls to new_call_channel() inside rakia/media-manager.c for more details.

If RakiaCallChannel constructed was requested by the local user up two new media streams would be created and added to it; the media can be audio or video. The media streams, known as a RakiaSipMedia object, is either created by the CallChannel constructed method if InitialAudio or InitialVideo is passed or by a later call to AddContent() on the D-Bus interface org.freedesktop.Telepathy.Channel.Type.Call1.

The creation of a Content object adds a “m=” line in the SDP in the SIP message body. Refer to the RFC 3261 specification.

The last important concept is a CallStream, implemented here as RakiaCallStream. A CallStream represents either a video or an audio stream to one specific remote participant, and is created through rakia_call_content_add_stream() every time a new Content object is created. In telepathy-rakia each Content object only has only one Stream because only one-to-one calls are supported.

Writing new Folks backends

The Folks documentation on backends is fairly extensive and can help quite a lot when writing a new backend. Each backend should provide a subclass of Folks.Backend.

15 http://telepathy.freedesktop.org/spec/Connection_Interface_Requests.html
16 http://telepathy.freedesktop.org/spec/Channel_Type_Call.html#Property:InitialAudio
17 http://telepathy.freedesktop.org/spec/Channel_Type_Call.html#Property:InitialVideo
18 https://wiki.gnome.org/Folks
The same documentation can be found in the sources in the file `folks/backend.vala`.

The evolution-data-server (EDS) backend will be used as example here due it is extensive documentation. The EDS subclass for `Folks.Backend` is defined in `backend/eds/eds-backend.vala` in the sources.

A backend also needs to implement the `Folks.Persona`[^20] and `Folks.PersonaStore`[^21] subclasses. For EDS those are `Edsf.Persona`[^22] and `Edsf.PersonaStore`[^23], which can also be seen in the sources in `backends/eds/lib/edsf-persona.vala` and `backends/eds/lib/edsf-persona-store.vala`, respectively.

`Persona` is the representation of a single contact in a given backend, they are stored by a `PersonaStore`. One backend may have many `PersonaStore`s if they happen to have different sources of contacts. For instance, each EDS address book would have an associated `PersonaStore` to it. `Personas` from different `Backends` that represent the same physical person are aggregated together by `Folks` core as a `Individual`[^24].

The Telepathy backend also serves as a good example. As the EDS backend, it is well-implemented and documented.