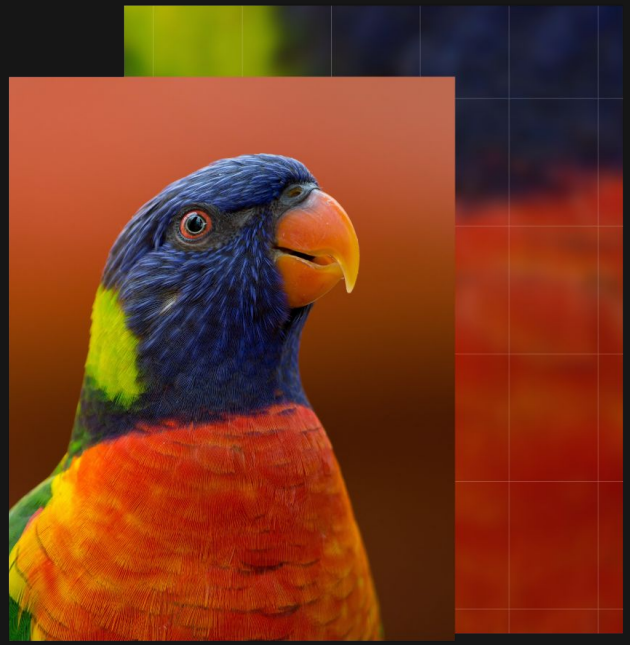
Patching 3rd-party plugin in runtime

Using one curious side effect of the Glib Dynamic Type System.



fluendo

GStreamer Conference 2023, Alexander Slobodeniuk

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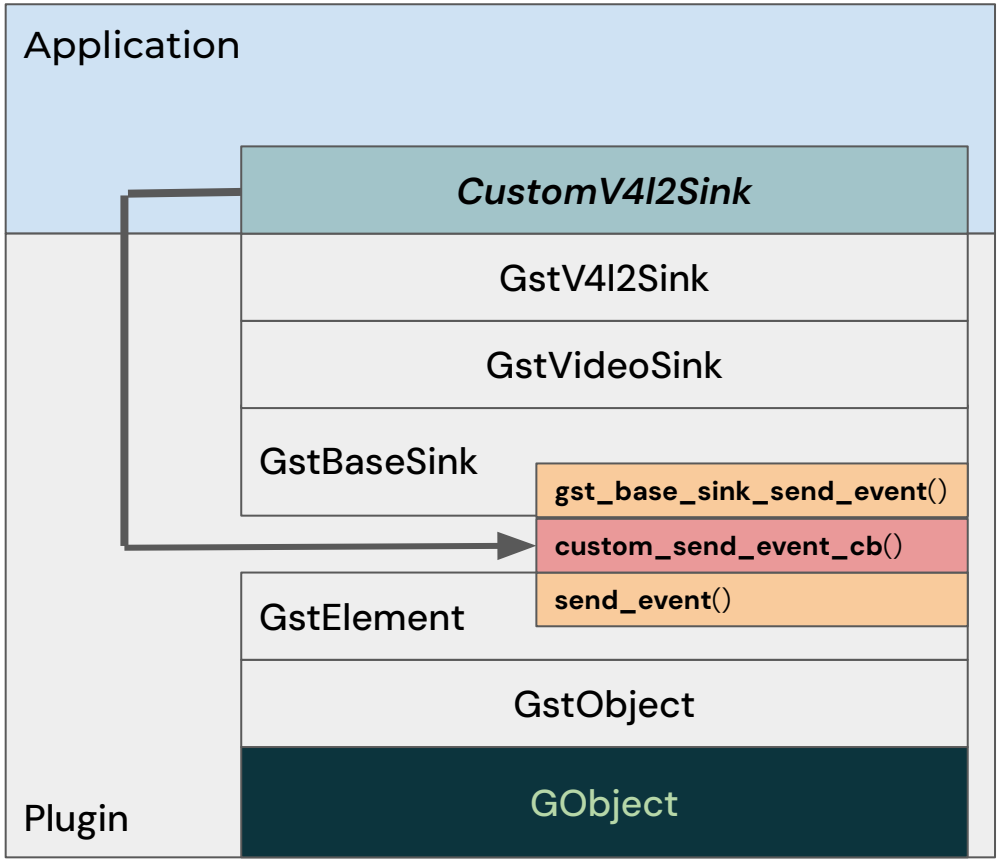
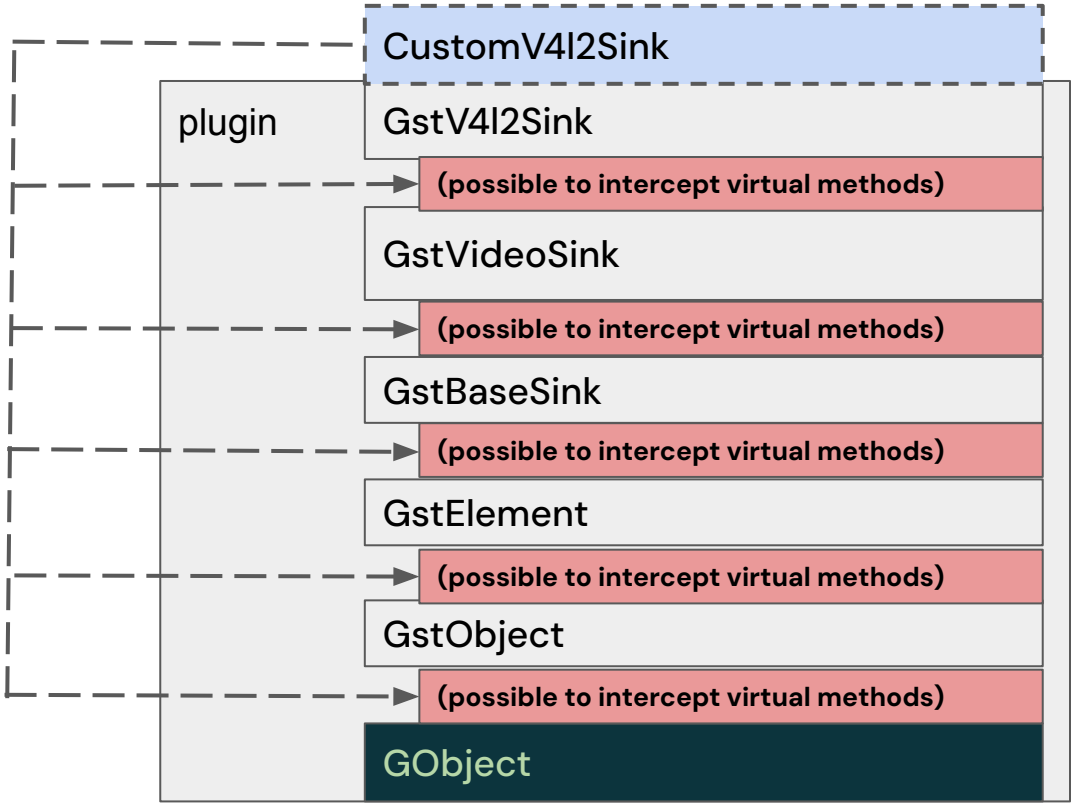
Overview

The goal of this presentation is to demonstrate some aspects of how Glib Dynamic Type System works, and how GStreamer framework manages to register its elements.



Custom code is a mixin, that is applied to a new class registered using any GStreamer element as a base class.



Registration of a new GstElement

```
static gboolean
plugin_init (GstPlugin * plugin)
{
...
  ret |= GST_ELEMENT_REGISTER (v4l2sink, plugin);
...
 }
```



```
gst_element_register (plugin, "v4l2sink", GST_RANK_PRIMARY, GST_TYPE_V4L2SINK);
```

gstv4l2sink.h

```
#define GST_TYPE_V4L2SINK \
  (gst_v4l2sink_get_type())
```

gstv4l2sink.c

```
G_DEFINE_TYPE_WITH_CODE (GstV4l2Sink, gst_v4l2sink, GST_TYPE_VIDEO_SINK,
    G_IMPLEMENT_INTERFACE (GST_TYPE_TUNER, gst_v4l2sink_tuner_interface_init);
    G_IMPLEMENT_INTERFACE (GST_TYPE_COLOR_BALANCE,
        gst_v4l2sink_color_balance_interface_init);
    G_IMPLEMENT_INTERFACE (GST_TYPE_VIDEO_ORIENTATION,
        gst_v4l2sink_video_orientation_interface_init));
```

G_DEFINE_TYPE / G_DEFINE_TYPE_WITH_CODE

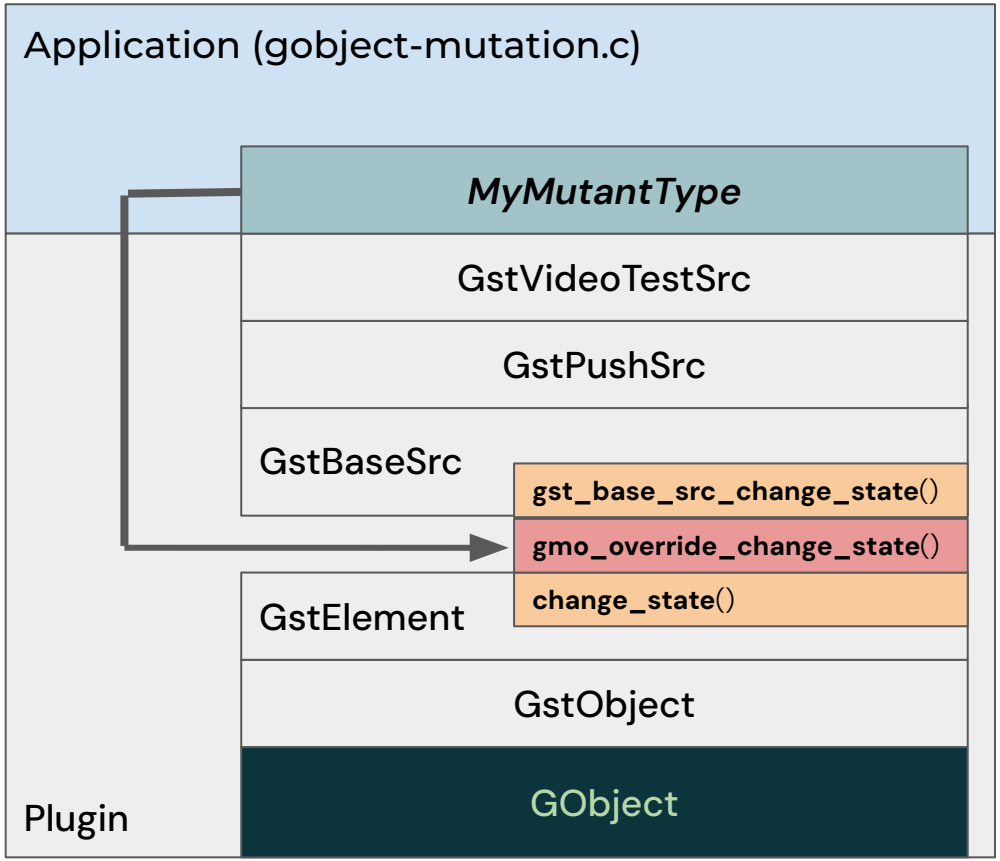
```
GType
gst_v4l2sink_get_type (void)
{
 static gsize v4l2sink_type = 0;

  if (g_once_init_enter (&v4l2sink_type)) {
    static const GTypeInfo base_sink_info = {
     ...
    };
    _type = g_type_register_static (GST_TYPE_VIDEO_SINK,
       "GstV4l2Sink", &v4l2sink_info, 0);

... (install interfaces)...

    g_once_init_leave (&v4l2sink_type, _type);
  }

  return v4l2sink_type;
}
```

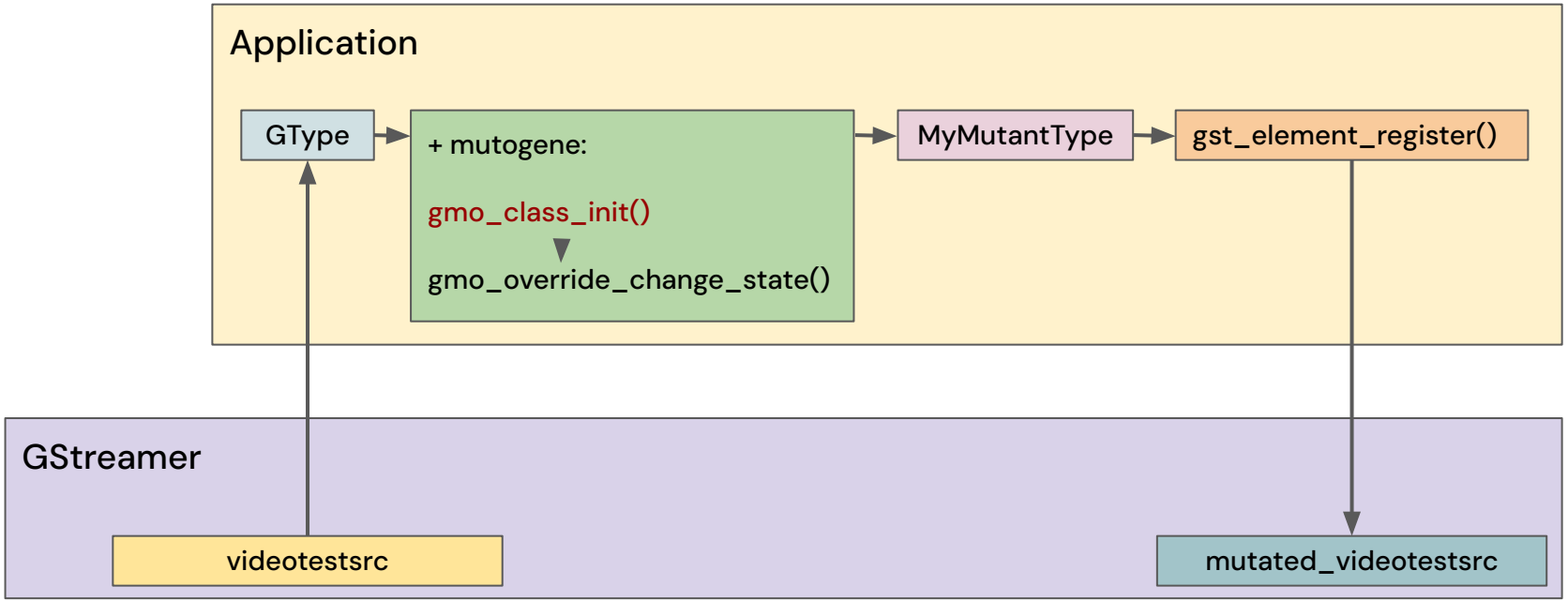
struct GTypeInfo

```
struct GTypeInfo {
  /* interface types, classed types, instantiated types */
  guint16             class_size;

  GBaseInitFunc       base_init;
  GBaseFinalizeFunc   base_finalize;

  /* interface types, classed types, instantiated types */
  GClassInitFunc      class_init;
  GClassFinalizeFunc  class_finalize;
  gconstpointer       class_data;

  /* instantiated types */
  guint16             instance_size;
  guint16             n_preallocs;
  GInstanceInitFunc   instance_init;

  /* value handling */
  const GTypeValueTable *value_table;
};
```

Walking through a code example

Code example can be found here (200 lines of code).




Application
GType
+ mutogene:
gmo_class_init()
gmo_override_change_state()
MyMutantType
gst_element_register()
GStreamer
videotestsrc
mutated_videotestsrc

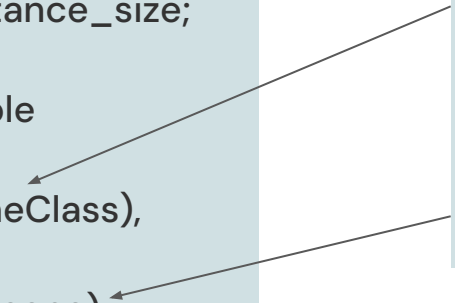
Getting the source type

```
GType dna_type;
...

{                       /* Get the DNA type */
  GstElementFactory *fac;

  fac = GST_ELEMENT_FACTORY (gst_plugin_feature_load (GST_PLUGIN_FEATURE
        (gst_element_factory_find ("videotestsrc"))));
  dna_type = gst_element_factory_get_element_type (fac);
  gst_object_unref (fac);
}
```

Registering the mutant type

```
g_type_query (dna, &dna_info);
 /* set offsets */
 gmo_dna_class_offset = dna_info.class_size;
 gmo_dna_instance_offset = dna_info.instance_size;

 return (ret = g_type_register_static_simple
    (dna, "MyMutantType",
        dna_info.class_size + sizeof (MutogeneClass),
        gmo_class_init,
        dna_info.instance_size + sizeof (Mutogene),
        gmo_init,
        0));
```

```
typedef struct
{
  int abc;
} MutogeneClass;

typedef struct
{
  guint num;
} Mutogene;
```



Intercepting a virtual function

```
static void
gmo_class_init (gpointer dna, gpointer class_data)
{
  MutogeneClass *klass;
  GstElementClass *element_class = (GstElementClass *) dna;

  parent_class = g_type_class_peek_parent (dna);

  klass = gmo_get_class (dna);
  klass->abc = 123;

  element_class->change_state = gmo_override_change_state;
}
```

```
static GstStateChangeReturn
gmo_override_change_state (GstElement * element,
GstStateChange transition)
{
  Mutogene *mut = gmo_get_mutogene (element);

  g_message ("Changing state to %s. Will count it as number %d",
      gst_element_state_get_name
(GST_STATE_TRANSITION_NEXT (transition)),
      ++mut->num);

  return parent_class->change_state (element, transition);
}
```

Chain up to parent class (GstVideoTestSrcClass)

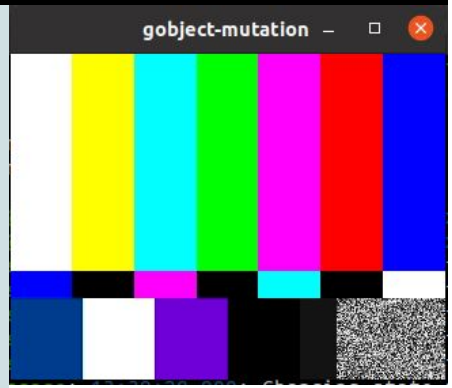
Registering a new GStreamer element

```
/* Register our mutant as GstElement */
 if (!gst_element_register (NULL, "mutated_videotestsrc", 999,
        mutated_dna_type)) {
   g_error ("Couldn't register mutant element");
 }

 pipe = gst_parse_launch ("mutated_videotestsrc ! autovideosink", NULL);
 g_assert (NULL != pipe);
 gst_element_set_state (pipe, GST_STATE_PLAYING);
```

Running the example

```
> cc gobject-mutation.c $(pkg-config --cflags --libs gstreamer-1.0) -o gobject-mutation
> ./gobject-mutation
** Message: 13:46:09.380: Hello from MyMutantType, the child of GstVideoTestSrc
** Message: 13:46:09.394: Changing state to READY. Will count it as number 1
** Message: 13:46:09.394: Changing state to PAUSED. Will count it as number 2
** Message: 13:46:09.408: Changing state to PLAYING. Will count it as number 3
** Message: 13:46:29.395: Changing state to PAUSED. Will count it as number 4
** Message: 13:46:29.396: Changing state to READY. Will count it as number 5
** Message: 13:46:29.430: Changing state to NULL. Will count it as number 6
>
```

```c
static void gmo_init (GTypeInstance * dna, gpointer klass)
{
  Mutogene *mut;

  mut = gmo_get_mutogene (dna);
  mut->num = 0;

  g_message ("Hello from %s, the child of %s", G_OBJECT_CLASS_NAME (klass),
      G_OBJECT_CLASS_NAME (parent_class));
}
```



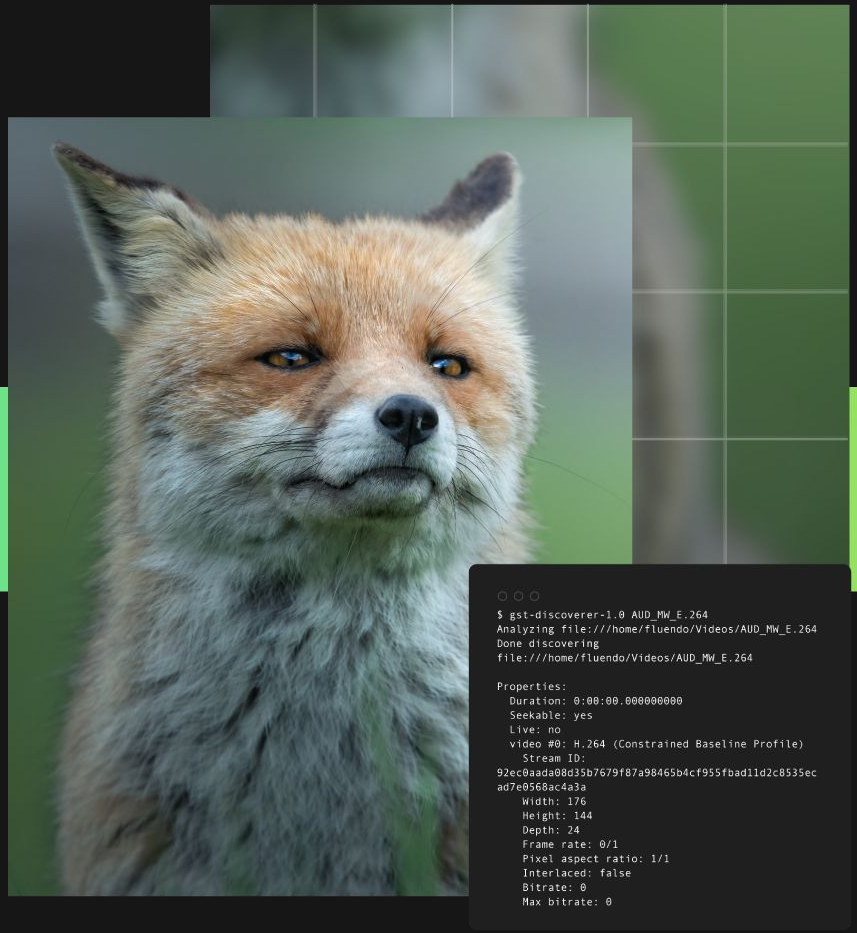
Possible use cases

- GStreamer already has pad probes that cover most of the need, and also tracers
- Any virtual function of an available base class can be intercepted
- The implementation of the “patch” (mutogene) is agnostic to it’s parent.
- The method seems to be stable and clear, but still looks like a hack

Examples that appear in mind:

- add “preroll” or “render” signals to any sink
- intercept handling an upstream event on any sink
- add “fill” signal to any source
- intercept metadata filtering on encoders or decoders
- intercept “provide_clock” of GstElement

Questions



```
$ gst-discoverer-1.0 AUD_MW_E.264
Analyzing file:///home/fluendo/Videos/AUD_MW_E.264
Done discovering
file:///home/fluendo/Videos/AUD_MW_E.264

Properties:
  Duration: 0:00:00.000000000
  Seekable: yes
  Live: no
  video #0: H.264 (Constrained Baseline Profile)
    Stream ID:
92ec0aada08d35b7679f87a98465b4cf955fbad11d2c8535ec
ad7e0568ac4a3a
    Width: 176
    Height: 144
    Depth: 24
    Frame rate: 0/1
    Pixel aspect ratio: 1/1
    Interlaced: false
    Bitrate: 0
    Max bitrate: 0
```

Thank you!