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Using Rust for building multimedia pipelines using GStreamer

Sanchayan Maity

asymptotic.io

Who?

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- Who are we?

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  - Open source consulting firm based out of Bangalore and Toronto

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GStreamer

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- Simple pipeline

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  - Totem (movie player for the GNOME desktop)

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  - Memory safety and concurrency
  - Foreign Function Interface
  - Tooling (bindgen, rust-analyzer . . .)

Why immutability and types matter?

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```
let caps: gst::Caps = gst::Caps::builder("video/x-raw")
    .field("width", crop_w)
    .field("height", crop_h)
    .field("pixel-aspect-ratio", gst::Fraction::new(1, 1))
    .build();
let s = caps.remove_structure(0);
```

Why immutability and types matter?

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```
warning: unused variable: `s`
   --> video-bin/src/imp.rs:152:13
    |
152 |         let s = caps.remove_structure(0);
    |             ^ help: if this is intentional, prefix it with an
    |               underscore: `_s`
    |
    = note: `#[warn(unused_variables)]` on by default
error[E0596]: cannot borrow data in dereference of `gstreamer::Caps`
              as mutable
   --> video-bin/src/imp.rs:152:17
    |
152 |         let s = caps.remove_structure(0);
    |                 ^^^^^^^^^^^^^^^^^^^^^^^^ cannot borrow as mutable
    |
    = help: trait `DerefMut` is required to modify through a dereference,
            but it is not implemented for `gstreamer::Caps`
```

Why immutability and types matter?

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```
let mut caps: gst::Caps = gst::Caps::builder("video/x-raw")
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    .build();
let _s = caps.remove_structure(0);
```

Why immutability and types matter?

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```
warning: variable does not need to be mutable
   --> video-bin/src/imp.rs:147:13
    |
147 |         let mut caps: gst::Caps = gst::Caps::builder("video/x-raw")
    |             ----^^^^
    |             |
    |             help: remove this `mut`
    |
    = note: `#[warn(unused_mut)]` on by default
error[E0596]: cannot borrow data in dereference of `gstreamer::Caps`
              as mutable
   --> video-bin/src/imp.rs:152:18
    |
152 |         let _s = caps.remove_structure(0);
    |                  ^^^^^^^^^^^^^^^^^^^^^^^^ cannot borrow as mutable
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    .field("pixel-aspect-ratio", gst::Fraction::new(1, 1))
    .build();
let caps = caps.get_mut().unwrap();
let _s = caps.remove_structure(0);
```

Why immutability and types matter?

asympt⟋tic

```
error[E0596]: cannot borrow `caps` as mutable, as it is not declared
              as mutable
   --> video-bin/src/imp.rs:152:20
    |
147 |         let caps: gst::Caps = gst::Caps::builder("video/x-raw")
    |             ---- help: consider changing this to be mutable:
    |                 `mut caps`
...
152 |         let caps = caps.get_mut().unwrap();
    |                    ^^^^^^^^^^^^^^ cannot borrow as mutable

For more information about this error, try `rustc --explain E0596`.
```

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    .field("width", crop_w)
    .field("height", crop_h)
    .field("pixel-aspect-ratio", gst::Fraction::new(1, 1))
    .build();
if let Some(caps) = caps.get_mut() {
    let _s = caps.remove_structure(0);
}
```

rustc explain

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```
This error occurs because you tried to mutably borrow a non-mutable
variable.
```

```
Erroneous code example:
```

let x = 1; let y = &mut x; // error: cannot borrow mutably

```
In here, `x` isn't mutable, so when we try to mutably borrow it in `y`,
it fails. To fix this error, you need to make `x` mutable:
```

let mut x = 1; let y = &mut x; // ok!

Daily's Streaming Architecture

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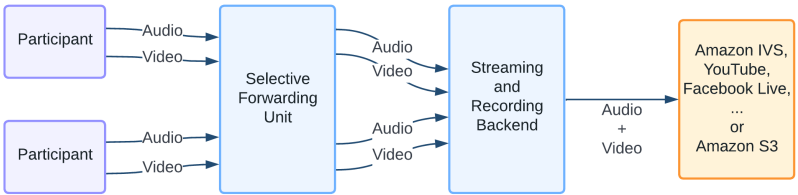

GStreamer pipeline

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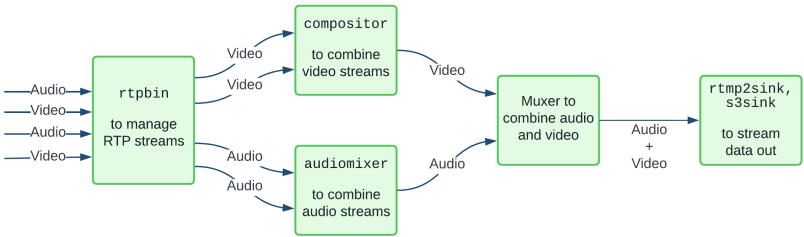

Like Lego

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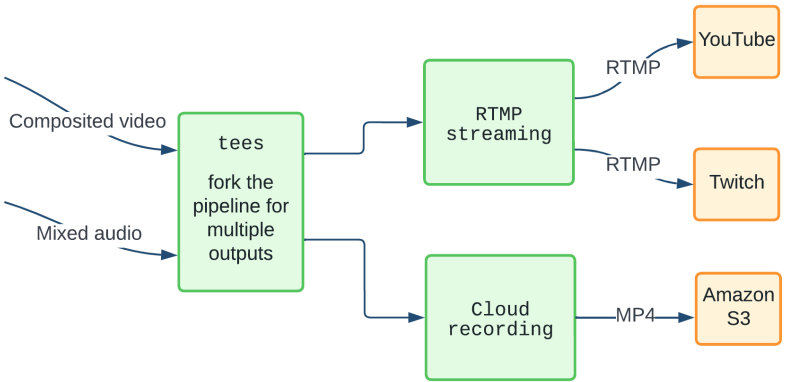

Custom elements

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```
gst-launch-1.0 filesrc location=bunny.mp4 ! decodebin ! videoconvert !
roundedcorners border-radius-px=100 ! videoconvert ! gtksink
```

Managing complexity

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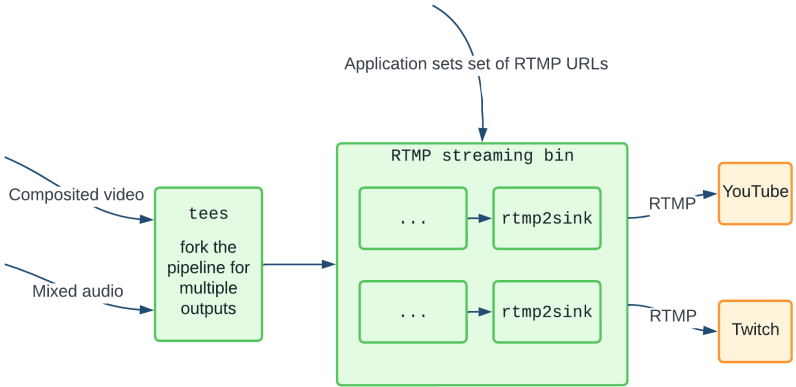

More custom elements

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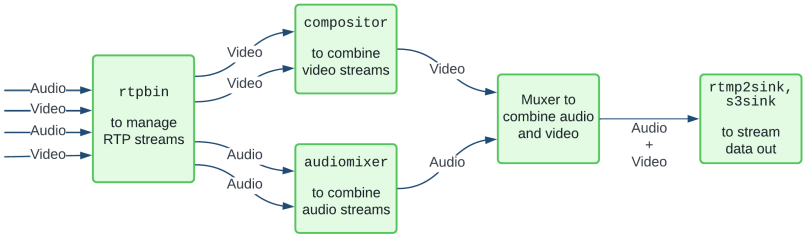

- Rounded corners (upstreamed)

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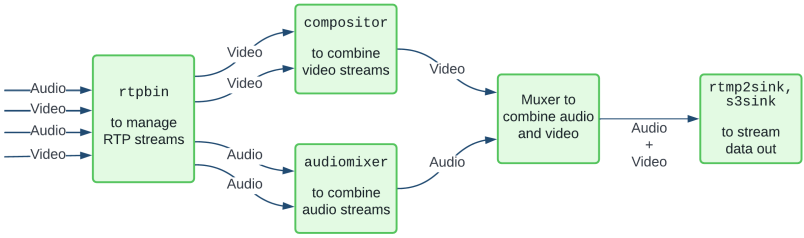

- Rounded corners (upstreamed)
- Overlay Composition

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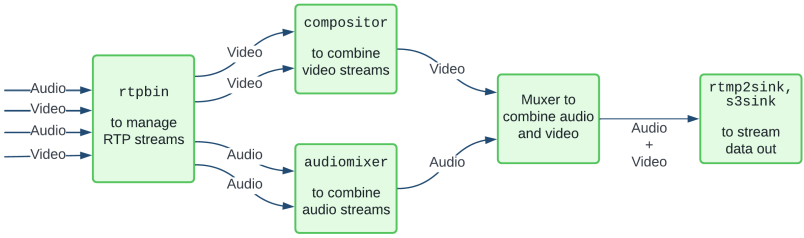

- Rounded corners (upstreamed)
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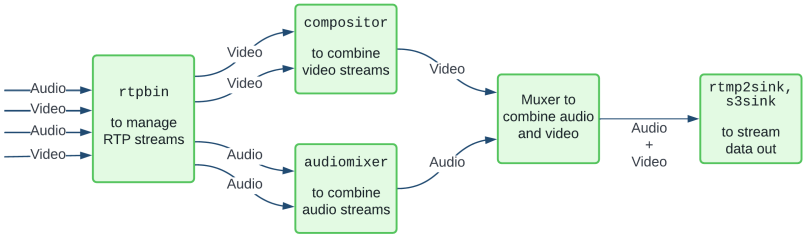

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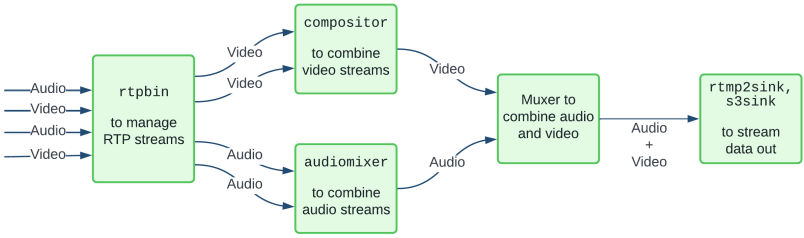

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- Recording

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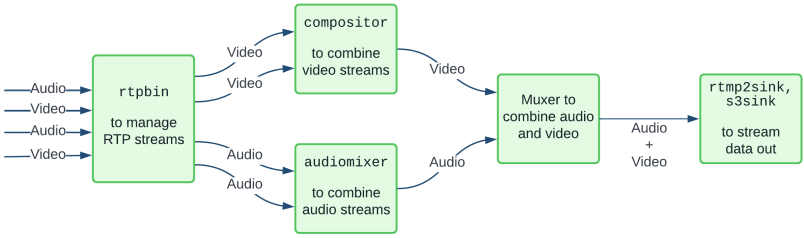

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- HTTP live streaming to AWS S3 (upstreamed)

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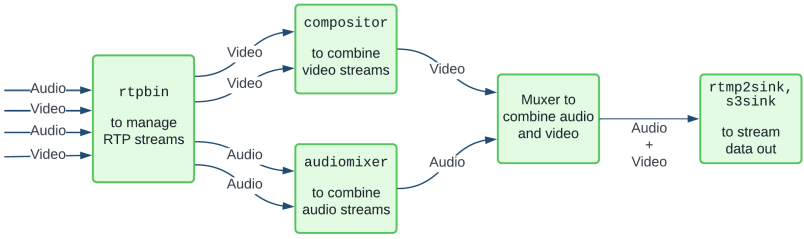

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