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More Efficient Streaming using Linux DRM Modifiers

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Open First

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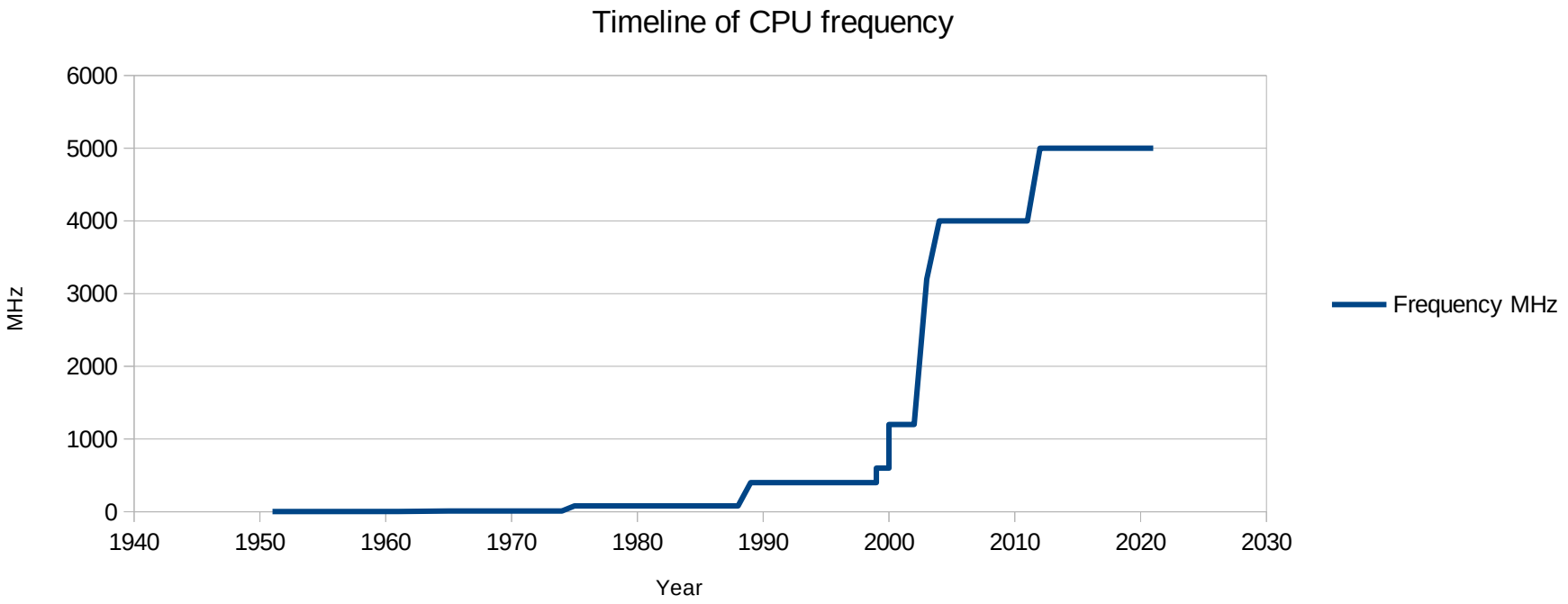
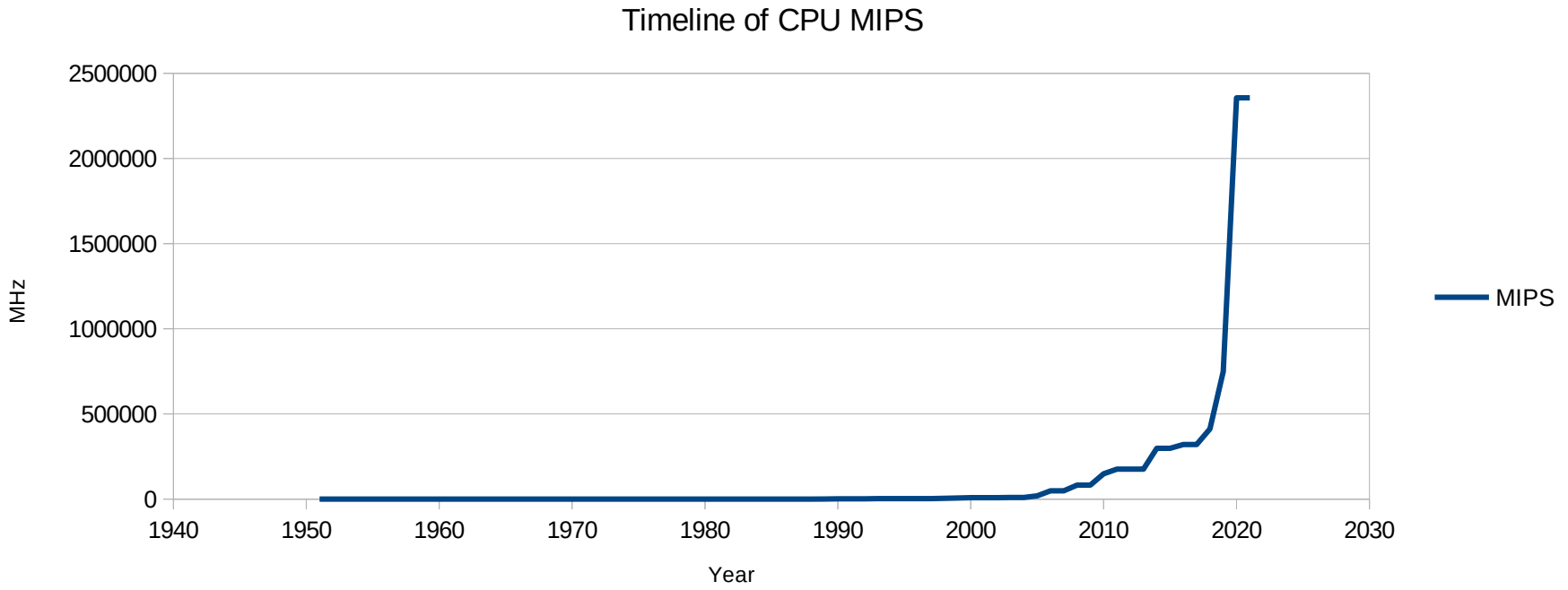
Are computers getting faster?

CPU frequency increase is slowing down



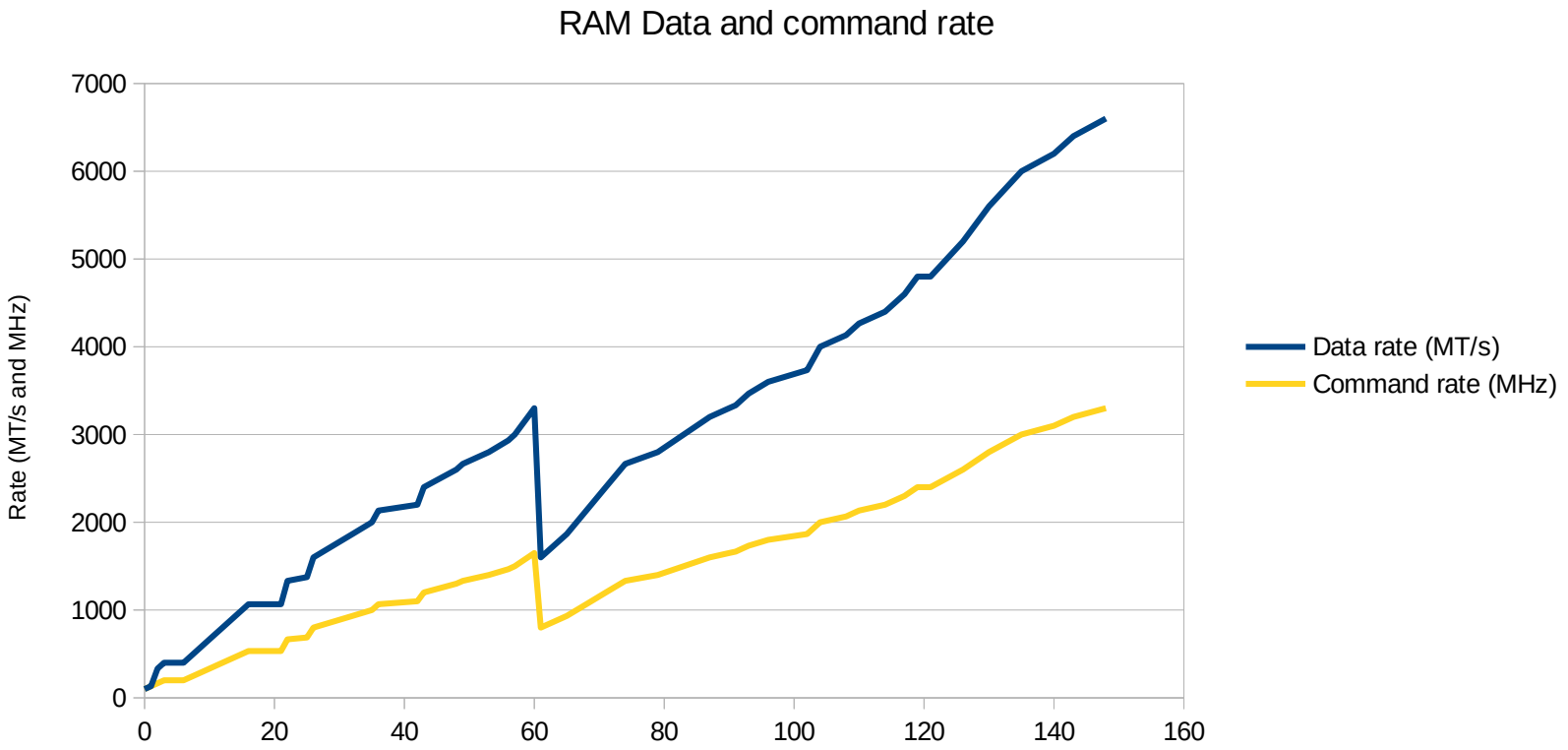
Data from https://en.wikipedia.org/wiki/Instructions_per_second

Core counts is still growing



Data from https://en.wikipedia.org/wiki/Instructions_per_second

RAM is also getting faster



Data from https://en.wikipedia.org/wiki/CAS_latency

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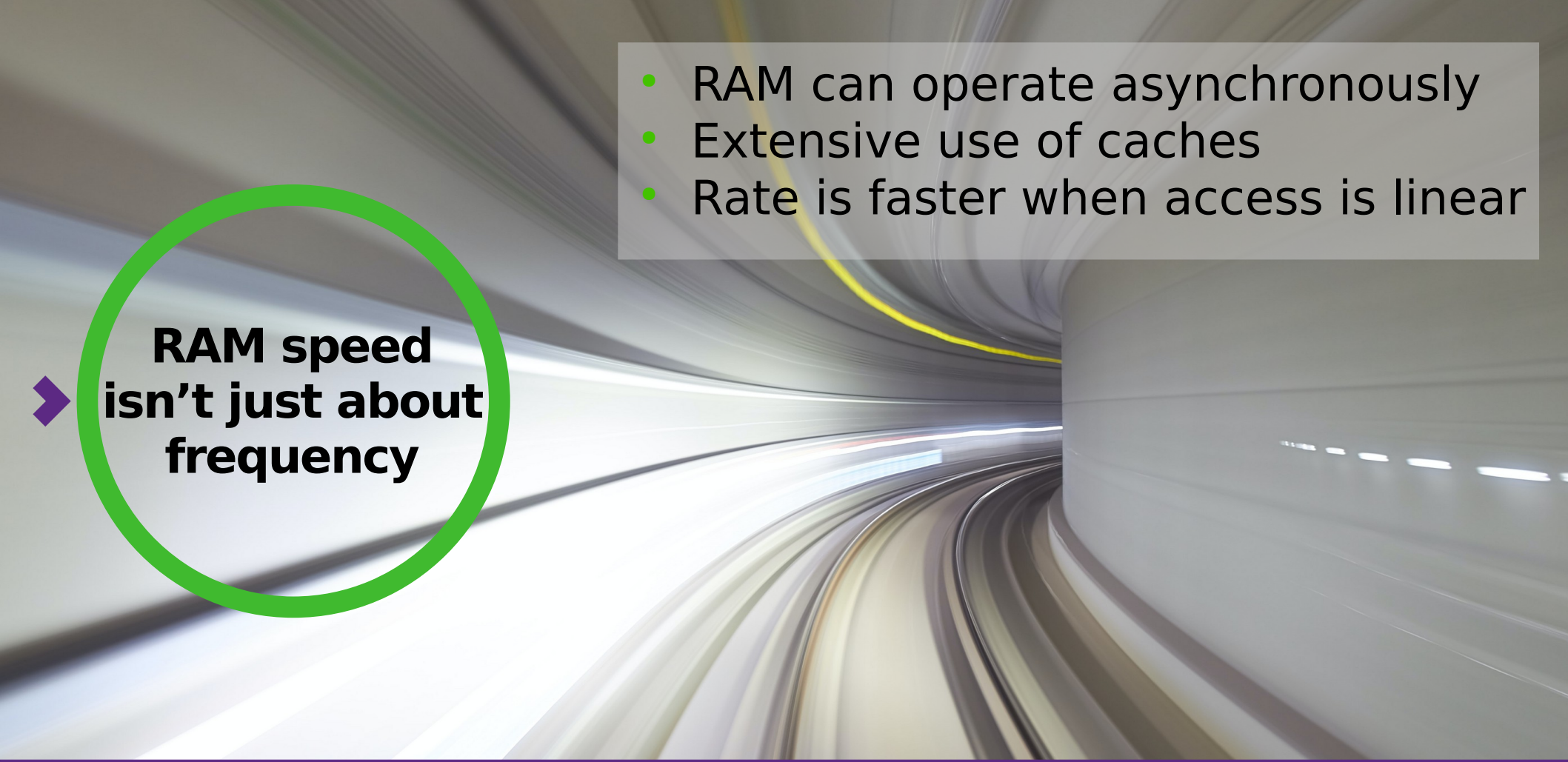
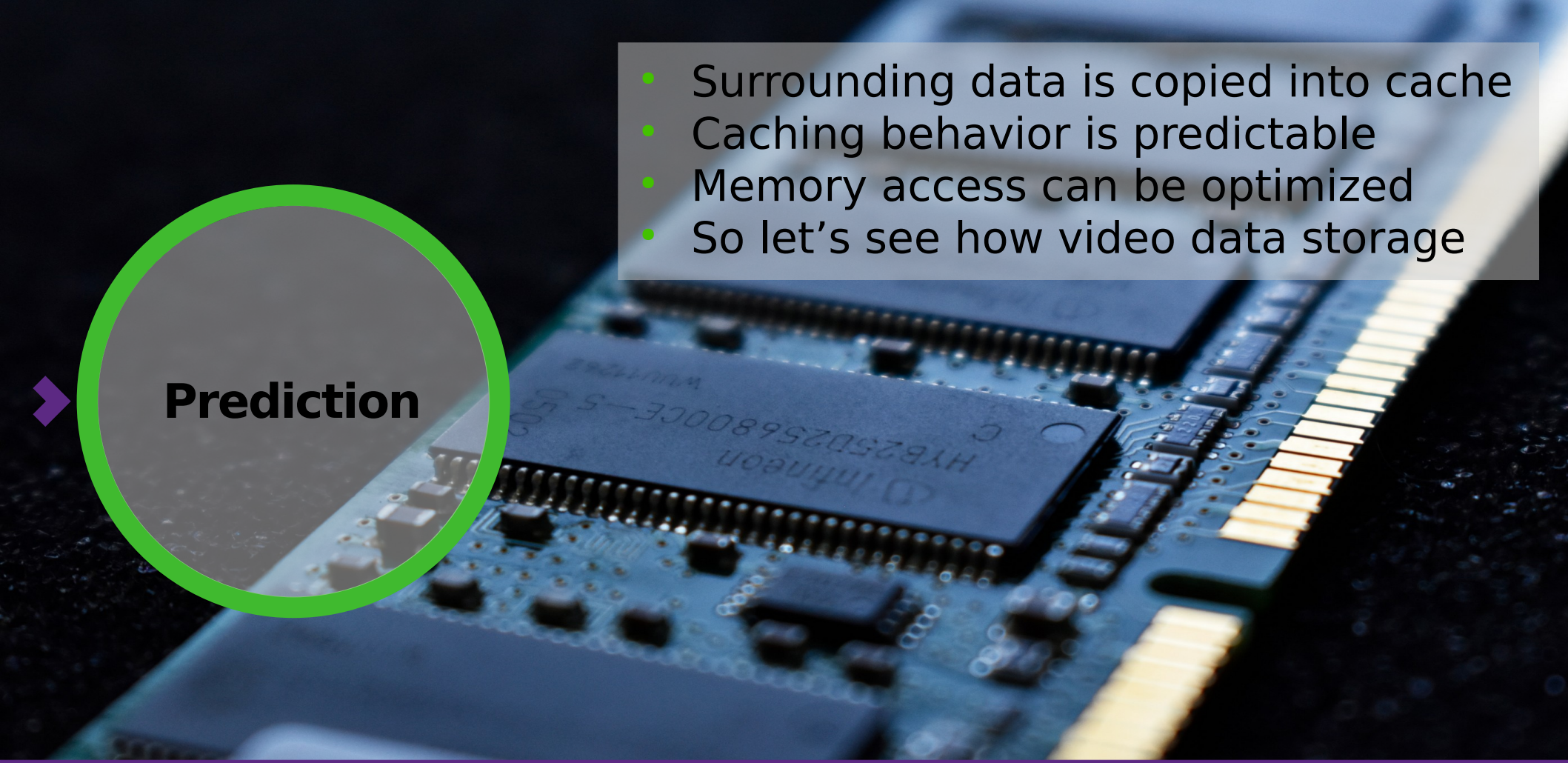
But they also feel faster, why?



- RAM can operate asynchronously
- Extensive use of caches
- Rate is faster when access is linear

RAM speed isn’t just about frequency

Photo by Mathew Schwartz on Unsplash

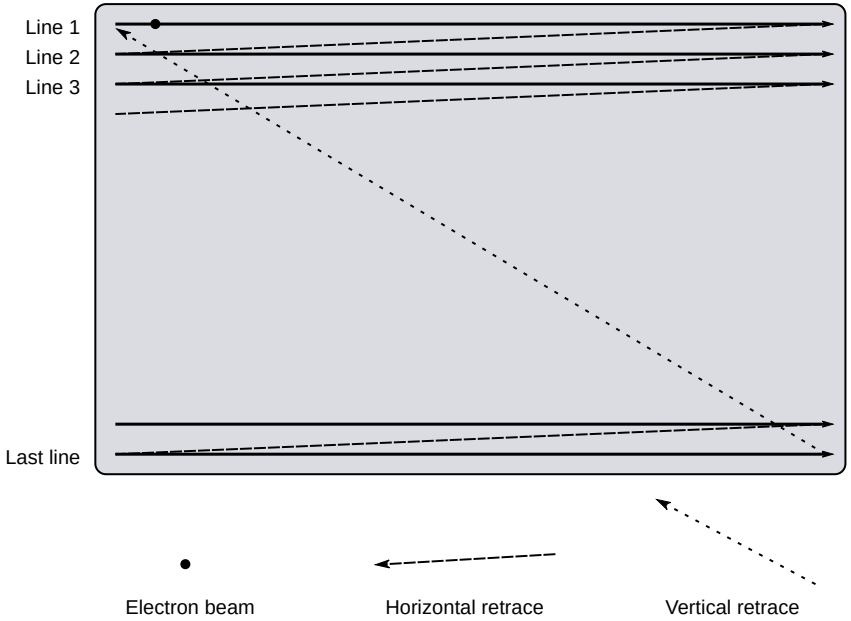


Prediction

- Surrounding data is copied into cache
- Caching behavior is predictable
- Memory access can be optimized
- So let’s see how video data storage

Photo by Liam Briese on Unsplash

Raster Scan



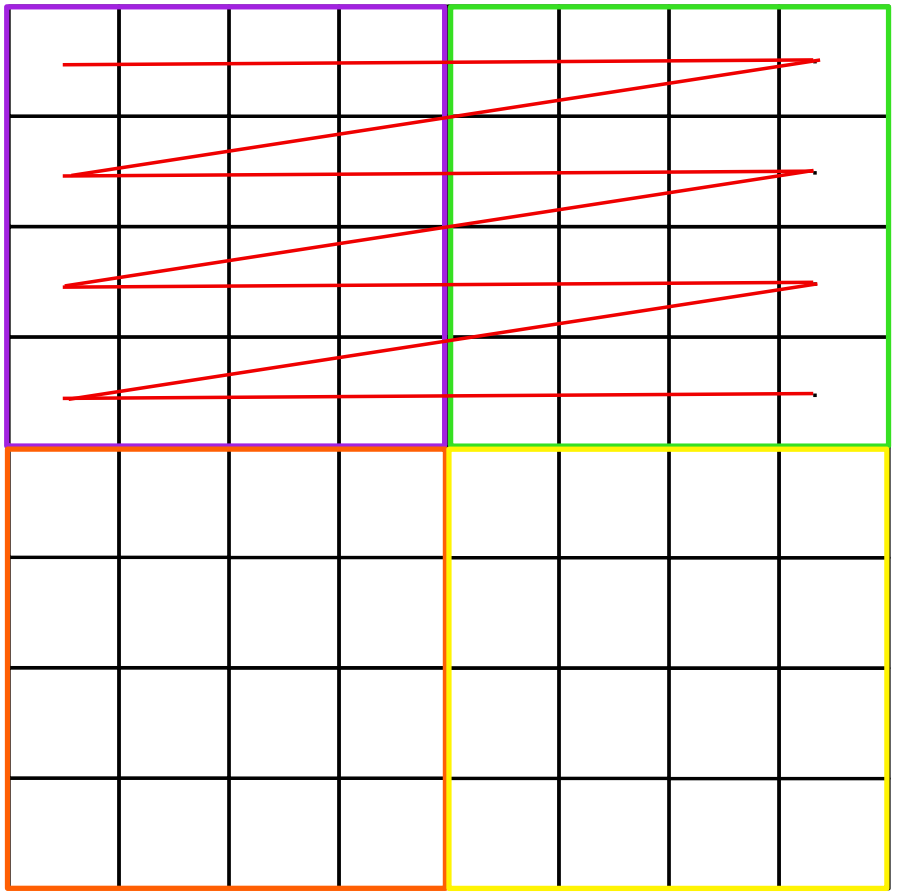
The use of raster scanning in television was proposed in 1880 by French engineer Maurice Leblanc

Illustration by Ian Harvey on Wikipedia

Raster Scan Use Cases

Top photo by Miss Zhang on Unsplash
Middle photo by Oğuzhan Akdoğan on Unsplash
Bottom photo by Mika Baumeister on Unsplash

Tiled Processing
(or raster images)



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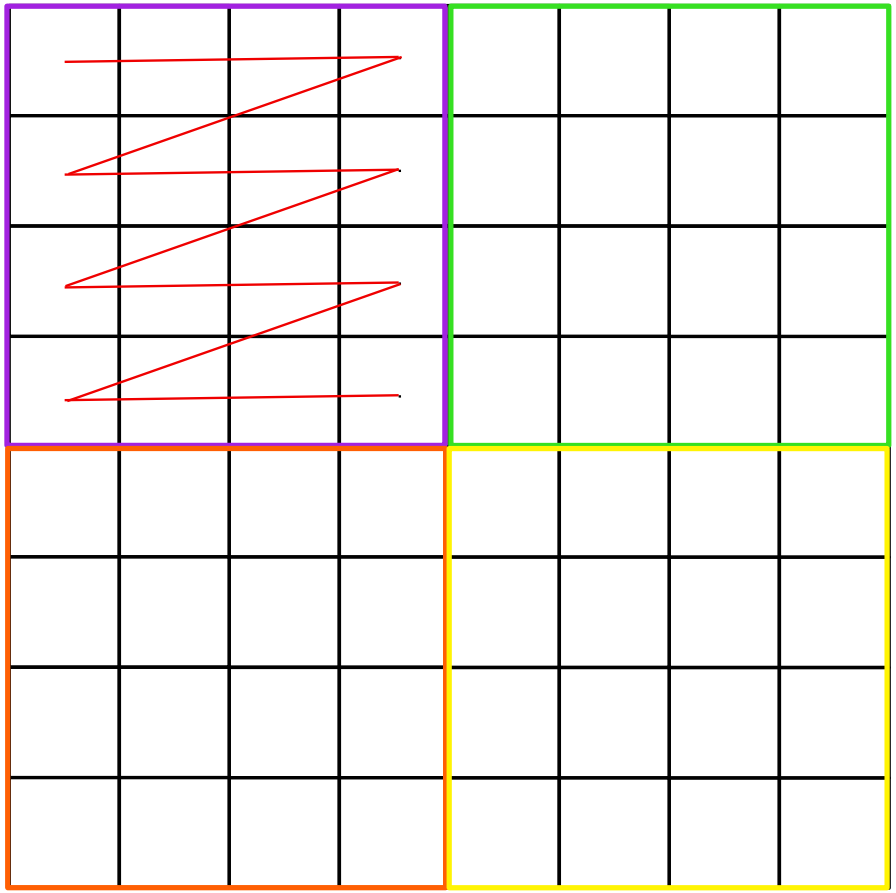
Different format, better performance

Tiled Processing



- Tiles can be square or rectangular
- Tiles can use full height
- Tiles can be combined with various inner pixel formats!

Tiles comes in all sort of flavors

Photo by Pratiksha Mohanty on Unsplash

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What if the bandwidth is the bottleneck ?

Unusual Video Frame

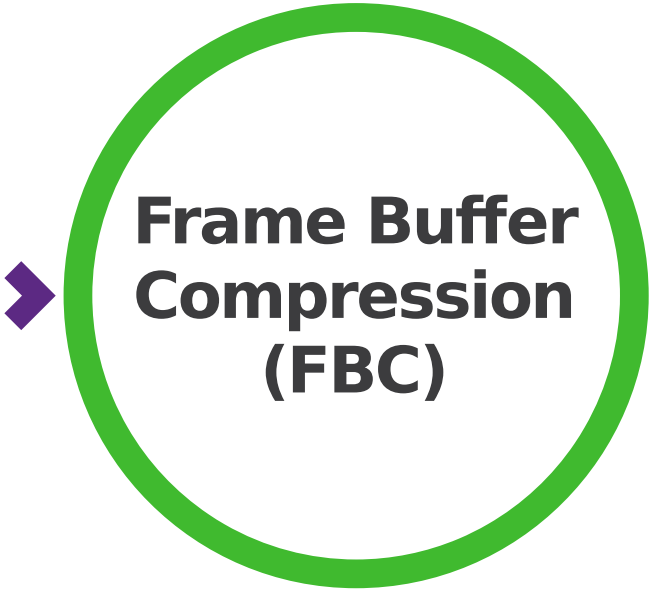
Randomly generate image

```
gst-launch-1.0 filesrc location=/dev/random  ! \
    rawvideoparse  width=1280 height=720 ! jpegenc ! identity eos-after=2 ! filesink location=test.jpg
```

Yes, its a bug!

Typical Video Frame

A frame from Big Buck Bunny movie, Blender Foundation



- FBC is implemented by memory controllers
- Lossless and low complexity compression
- Data is compressed before being stored
- Can reduce by half (sometimes more) the bandwidth utilization
- Does not save anything in storage size, always require more space

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How this used to be implemented ...

- Hidden under abstraction API like GL / VK / VA / D3D / etc.
- No interroperability, hence no sharing between Cameras, GPUs and even with some of the CODECs
- And when sharing is done implicitly ...

You get this!

By Rafał Dzięgiel on issue #1236

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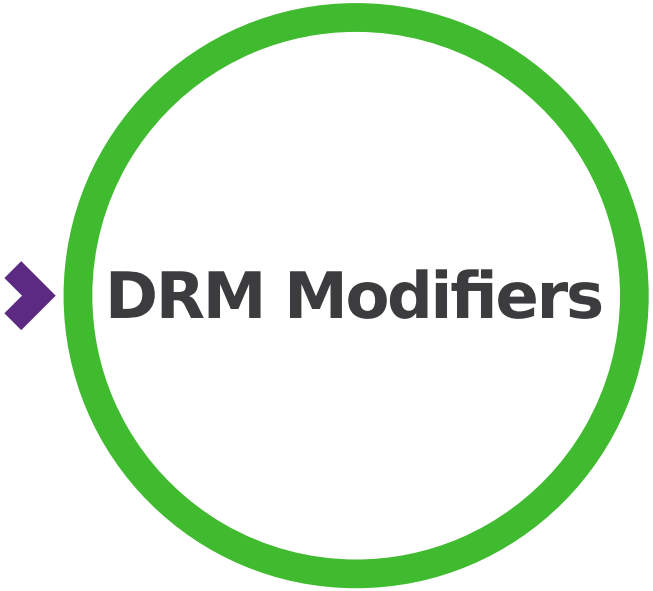
How did we fix that ?

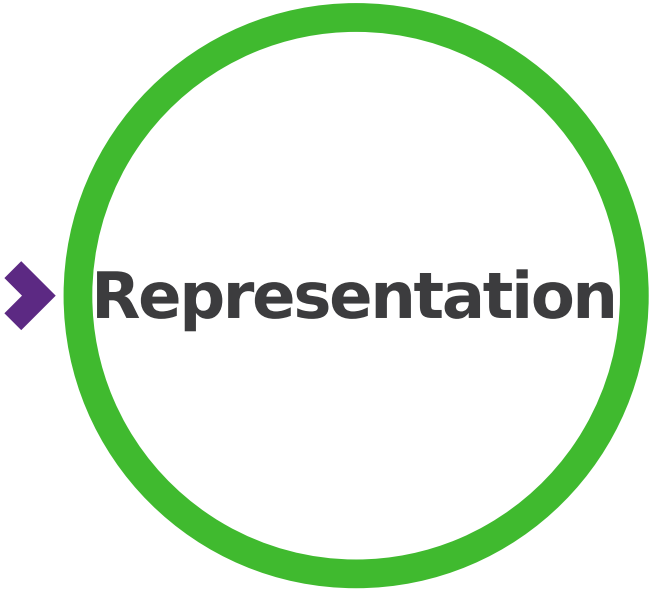
Explicit Negotiation

- NV12_64Z32, NV12_4L4, NV12_32L32, NV12_16L32S, NV12_8L128, NV12_10BE_8L128
- GPUs have hundreds of these

Photo by Lucas Kapla on Unsplash



- Direct Render Manager (DRM)
- This Linux kernel subsystem is where all Display and GPU drivers lives
- They bonified their pixel formats with a 64bits **modifier**
- The upper 8bits is a vendor ID
- Leaving 56bits to decribe the actual format



- DRM formats are defined as fourcc, a four characters string
- The DRM Modifier is represented as a 16 digits hexadecimal
- 0x0000000000000000 means Linear
- 0x00FFFFFFFFFFFFFF means invalid (or that modifiers are not supported)
- 0x0100000000000001 means Intel's X tile mode

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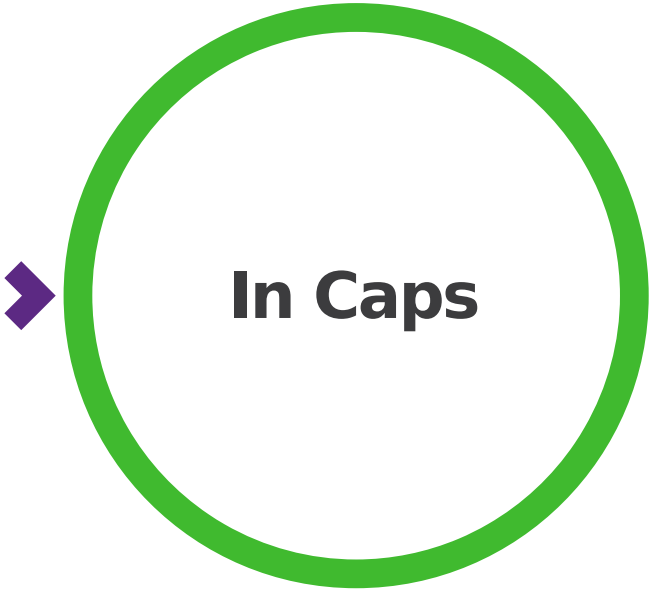
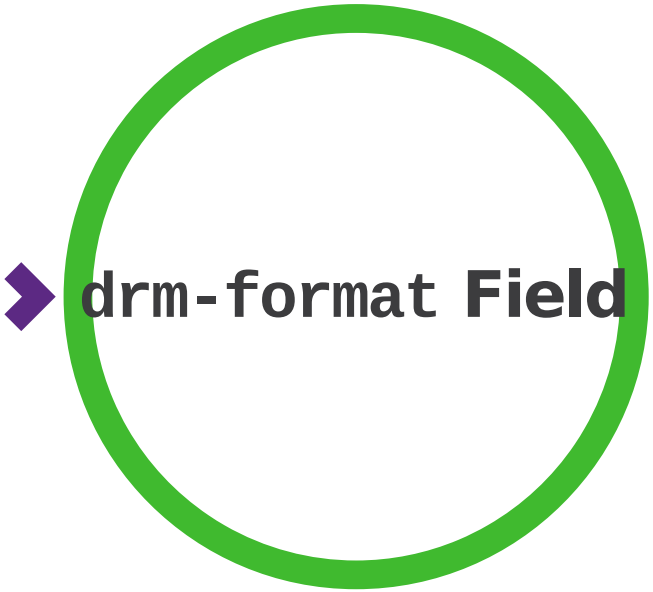
An overview DMABuf DRM format negotiation in GStreamer



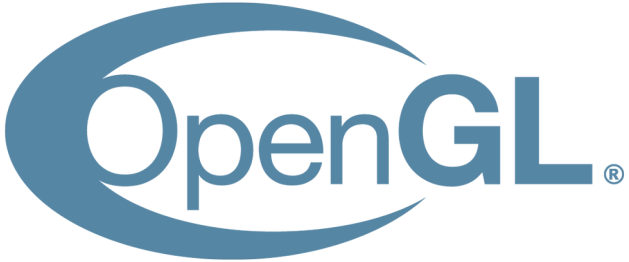
- Used with memory:DMABuf caps feature
- A DMABuf being the generic FD type used to share memory between drivers on Linux
- The **format=** field is always **DMA_DRM**
- The actual format is set in **drm-format** field



drm-format Field

- Form of the combination DRM fourcc and the modifier hexadecimal representation
- drm-format=<**fourcc**>:<**modifier**>
- video/x-raw(memory:DMABuf),
  format=(string)DMA_DRM,
  drm-format=(string)NV12:0x0100000000000001,
  width=(int)1920,
  height=(int)1080,

- Over the years, OpenGL, VA API, Wayland and of course Linux DRM subsystem enabled the ability to enumerate the supported combinations
- Wayland DMAbuf Feedback provide updates on rendering device changes (WIP in GStreamer)

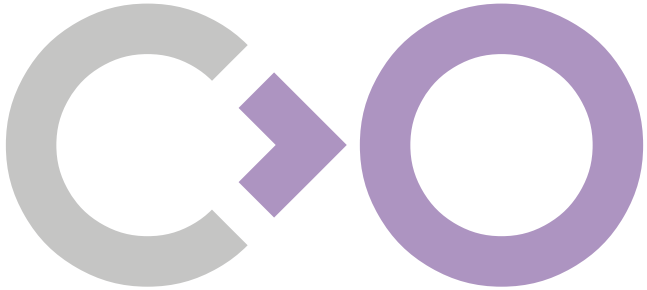


CAPS takes care of it!

By Rafał Dzięgiel on issue #1236

- GStreamer DMA Buffers design
- GstVideoInfoDMADrm helpers
- GStreamer DMABuf “allocator”
- A nice summary from Victor at Igalia

Thanks
He Junyan



Thank you!