PipeWire: The New Multimedia Service, Now Ready for Automotive

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Open First

Hi, I’m Julian

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What is PipeWire?

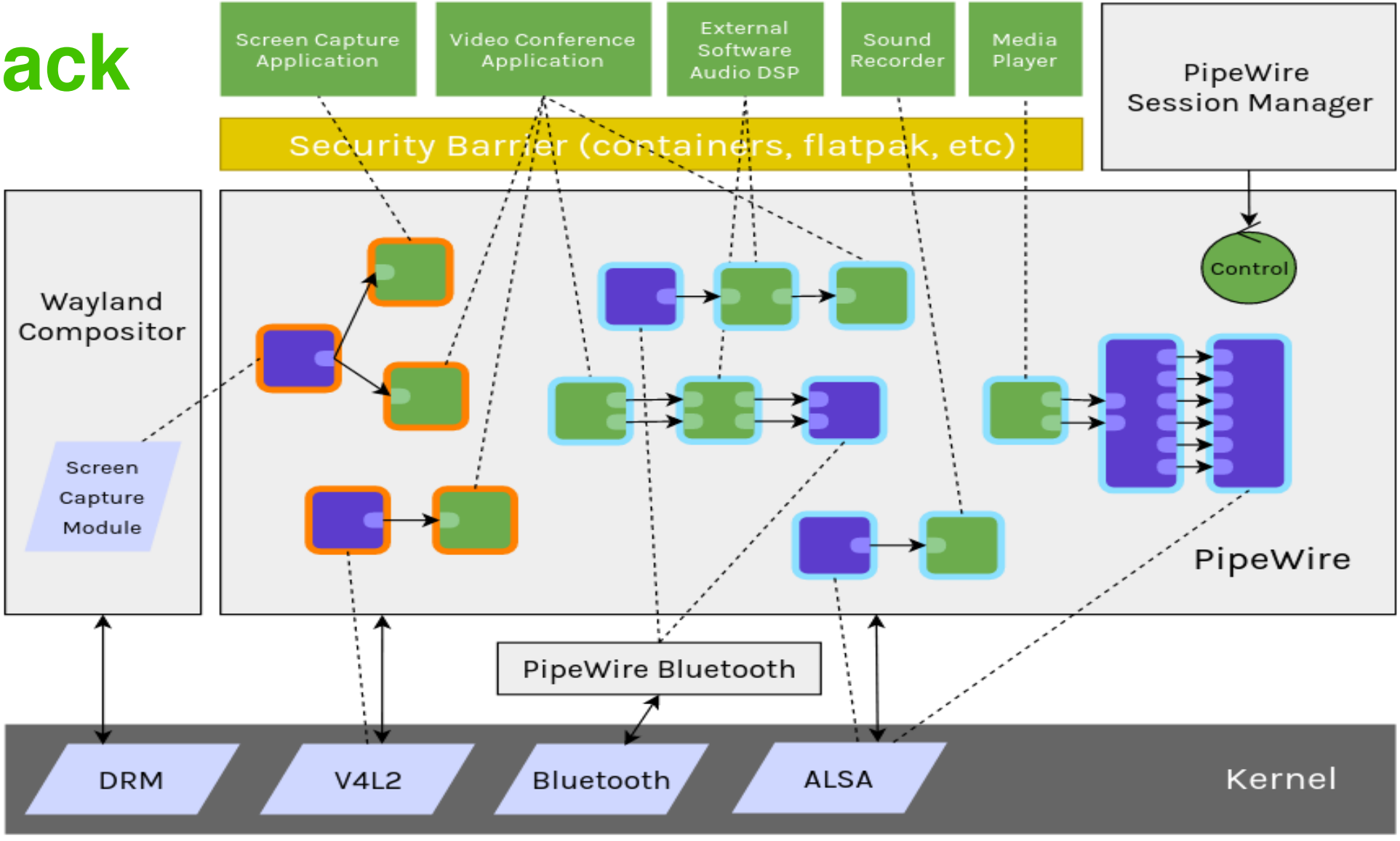
Fresh multimedia service for Linux

- Originally meant for video only: PulseAudio for Video (PulseVideo)
- Now generic multimedia service for both Video and Audio
- Video Capture:
  - Cameras
  - Graphic Sources (Wayland, Vulkan, OpenGL...)
- Audio Playback and Capture:
  - Microphone and Speakers
  - Bluetooth devices

Why do we need PipeWire?

- Unifies both PulseAudio and Jack audio servers, greatly simplifying the Linux Multimedia Stack
- Permissions: Supports containers like Flatpak and does not rely on *video* and *audio* user groups
- Low latency: can handle very small buffers sizes (e.g. 32 samples)
- Flexible: external Session Manager adaptable to any use cases

Stack


Screen Capture Application
Video Conference Application
External Software Audio DSP
Sound Recorder
Media Player
PipeWire Session Manager
Security Barrier (containers, flatpak, etc)
Wayland Compositor
Screen Capture Module
Control
PipeWire
PipeWire Bluetooth
DRM
V4L2
Bluetooth
ALSA
Kernel

Compatibility APIs on top of PipeWire

- ALSA applications
  - PipeWire PCM plugin
- PulseAudio applications
  - Replacement for libpulse.so and libpulse-mainloop-glib.so
- JACK applications
  - Replacement for libjack.so

Architecture and Design

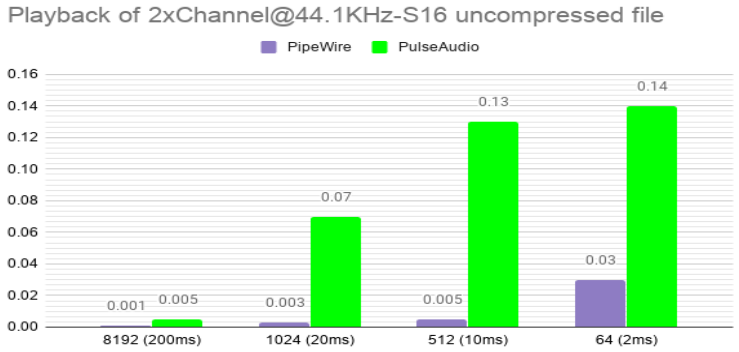
- Modular with Plugins
- Graph based like GStreamer: Nodes, Ports and Links
- Multi-Process:
  - Daemon processes most of the data (nodes can also run in the clients to avoid stalling)
  - External session manager configures and links the nodes
- Fully based on its internal and Simple Plugin API library (SPA)
  - Extremely simple and lightweight generic purpose multimedia library
  - Mostly header-only C library with no other dependencies (glib, GStreamer, etc...)

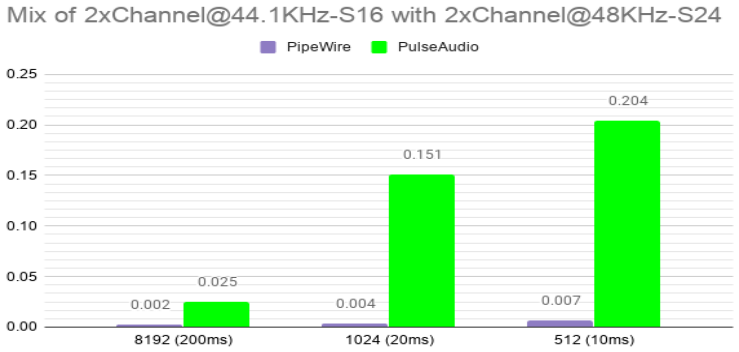
Performance and Efficiency

- Static code design approach
  - Almost no mallocs
- Uses modern Linux APIs
  - memfd & dmabuf to zero-copy device buffers
  - eventfd & timerfd for scheduling
- Low CPU Usage and low-latency real-time capable

CPU Usage against PulseAudio

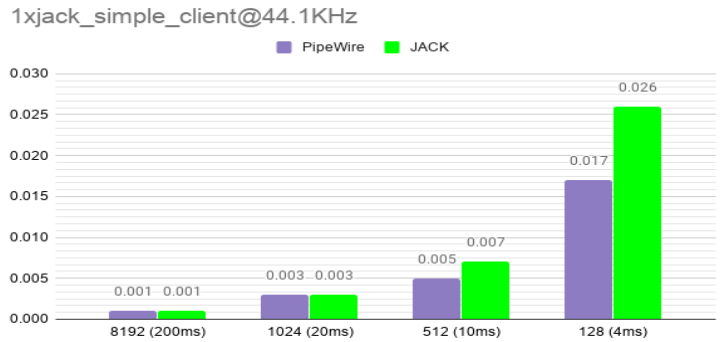
- Hardware: Intel(R) Core(TM) i7-4770 CPU @ 3.40GHz
- Source: PipeWire
- PipeWire handles buffer sizes of 32 samples, PulseAudio underruns

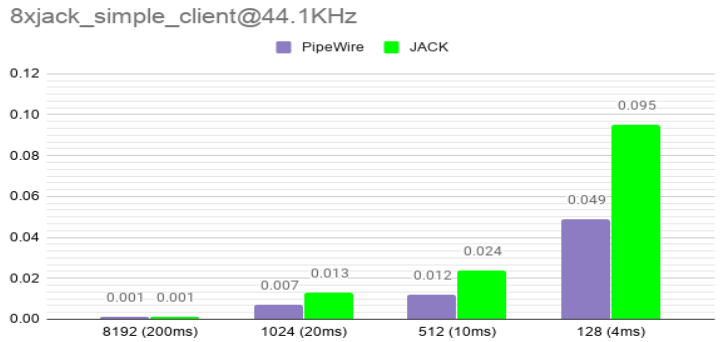




CPU Usage against JACK

- Hardware: Intel(R) Core(TM) i7-4770 CPU @ 3.40GHz
- Source: PipeWire
- PipeWire handles buffer sizes of 32 samples, JACK underruns





Security

- External Session Manager grants permissions to applications
- Nodes can be only visible for some applications
- Type of Permissions:
  - (R) Read: Visible, Capture data
  - (W) Write: Play data
  - (X) Execute: allow executing methods on objects (e.g. Setup format on nodes)

External Session Manager

- Not included in the PipeWire project
- Creates and Configures Devices to emit new Nodes
- Sets up Nodes (Format, Ports, etc...)
- Creates links based on its policy logic when a client connects
- Grants security and access control to clients (applications)
- Launched by the PipeWire daemon at startup

Current Status

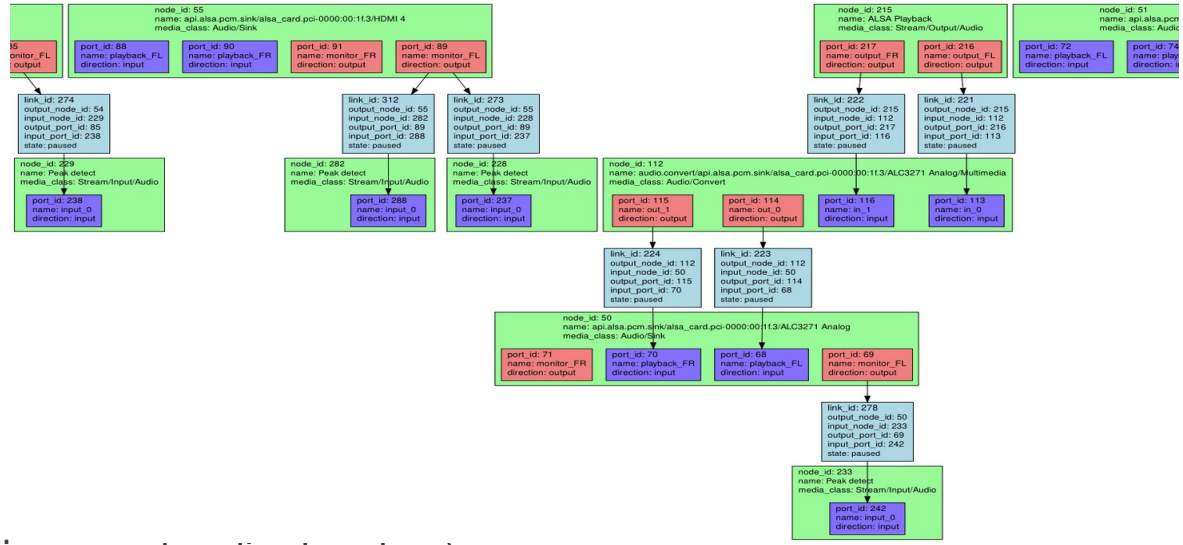
- Version 0.3.5 released in May 2020 and distributed in Fedora 32
  - Plenty of JACK applications already working with PipeWire
  - Many PulseAudio apps work as well
  - Bluetooth starting to be fully supported, needs more testing
  - Musical Instrument Digital Interface (MIDI) works
  - Plans to replace PulseAudio soon
  - Video capture from V4L2 devices works well
  - Wayland screencasting from weston, gnome-shell, and wlroots supported
- Adopted by AGL (Automotive Grade Linux) as the core audio framework

Who started this

- Author: Wim Taymans
  - Well-known old GStreamer developer & ex-maintainer
  - Sponsored by: Red Hat
- Embraced by PulseAudio developers
  - Seen as the next generation of PulseAudio
- Welcomed by ALSA and JACK developers
- License: MIT

PipeWire DOT tool

- Generates DOT graphs
- Usage:
  - $ pw-dot pw.dot [options]
- Options:
  - --all (shows all object types: nodes, devices, ports, clients, etc...)
  - --smart (only shows linked objects)
  - --details (show all object properties)



PipeWire in the Automotive Industry

Why PipeWire suits Automotive

- Problem: Device handling in connected cars is complex:
  - Plenty of speakers and cameras
  - Multiple audio streams: Radio, Emergency, Navigation, Communication...
  - Phone calls over Bluetooth
- Solution: PipeWire with a flexible external Session Manager
  - Custom policy logic
  - Custom hardware pipelines
  - Hardware control abstraction
  - Security

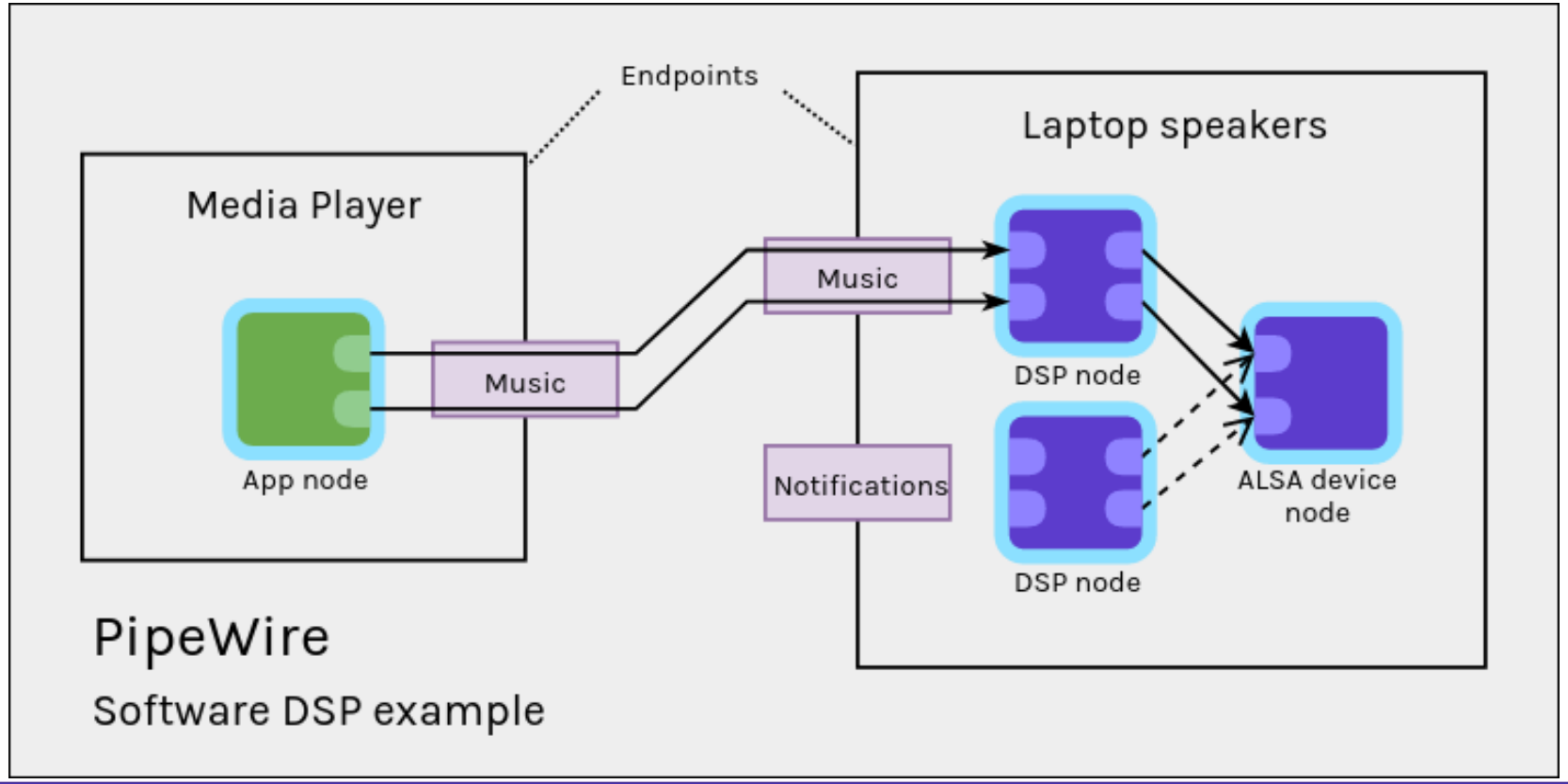
WirePlumber

- First external session manager implementation for PipeWire
- Originally planned for Embedded only (Automotive)
- Now generic and fully featured Session Manager for both Embedded and Desktop
- Based on GObject to support writing bindings in other languages: Rust, Python, LUA...

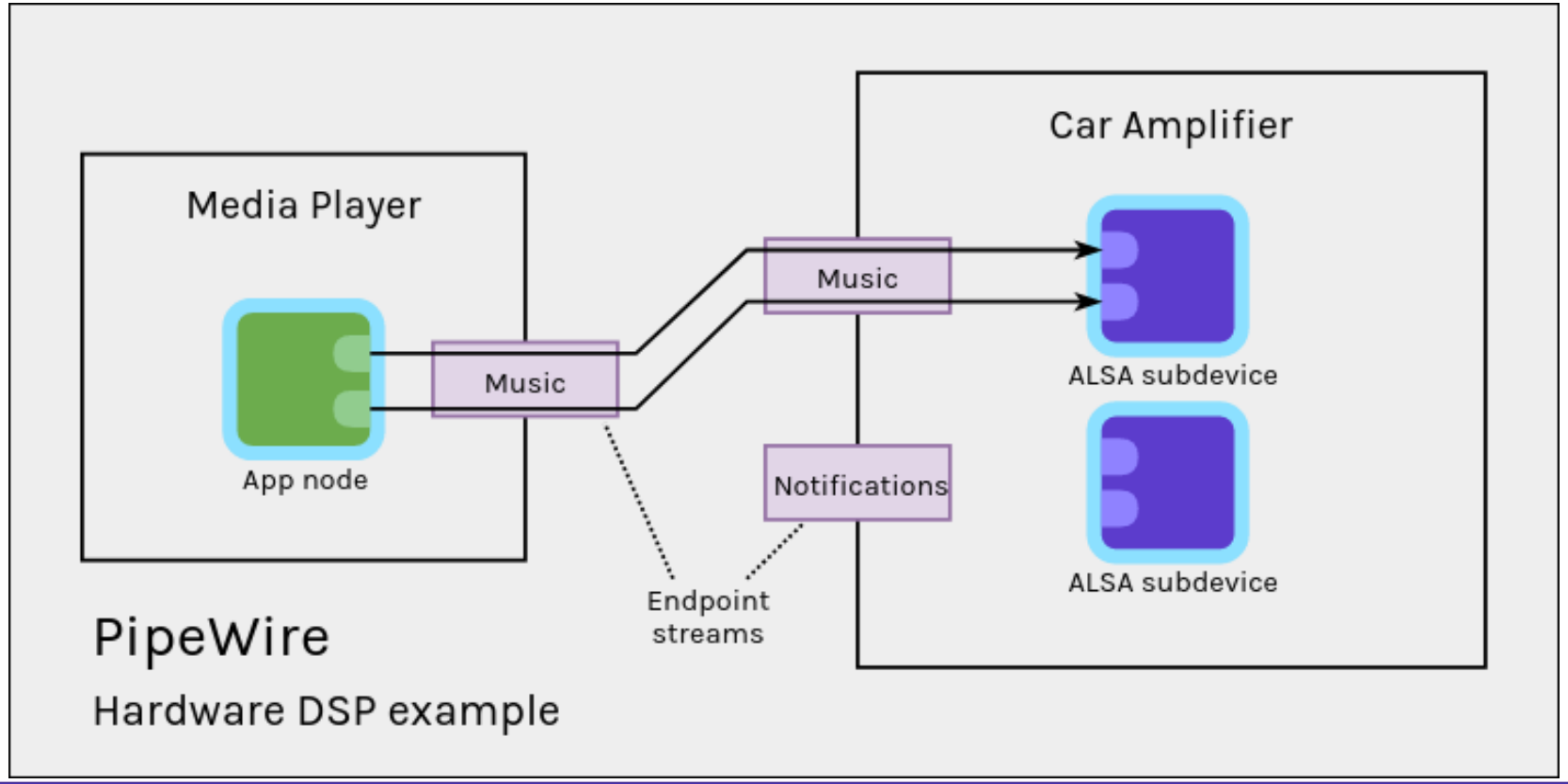
Introduction of new Objects

- Endpoint: object that handles PipeWire nodes
  - Audio Software DSP Endpoint
  - Simple Node Endpoint
- Stream: connection points of an Endpoint
- Session: set of Endpoints
  - Video Session
  - Audio Session

Software DSP example



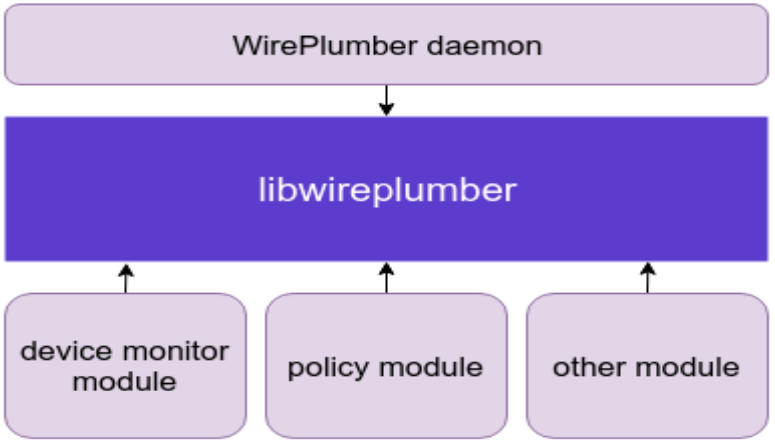
Hardware DSP Example



WirePlumber Design

- Provides an libwireplumber API that makes easy writing WirePlumber modules and even other session managers

- Modular design



WirePlumber Modules

- Monitor
  - monitors devices and creates nodes when enabled
- ClientPermissions
  - grants permissions to clients when connected
- ConfigEndpoint
  - creates different endpoints per nodes based on configuration files
- ConfigPolicy
  - links endpoints based on configuration files

Bindings example usages

- Python/Rust session manager to avoid use of low level PipeWire API and objects

- WirePlumber Module that interprets LUA files for quick and easy custom policy logic

WirePlumber Versions

- v0.1.0 (Jul 2019): used in AGL Happy Halibut 8.0.0
- v0.1.2 (Oct 2019): used in AGL Happy Halibut 8.0.2
- v0.2.0 (Dec 2019): used in both AGL Happy Halibut 8.0.5 and AGL Itchy Icefish 9.0.0
- v0.3.0 (June 2020): First version with Desktop Support

Future Release

- Support for Bindings in other languages
- Clean the API and make it stable (almost there)
- Improve Documentation
- More unit tests and examples

Who started this

- Author: George Kiagiadakis
  - Sponsored by: Collabora
- Welcomed by PipeWire developers
- Git repository:
  - https://gitlab.freedesktop.org/PipeWire/wireplumber
- Documentation:
  - https://PipeWire.pages.freedesktop.org/wireplumber
- License: MIT

Showtime

Thank you for watching

- Join us on IRC at #pipewire on Freenode
- https://gitlab.freedesktop.org/pipewire
- julian.bouzas@collabora.com