Data-Driven Haptic Feedback in Avatar: Frontiers of Pandora

Wojciech Mosiejczuk, Massive Entertainment

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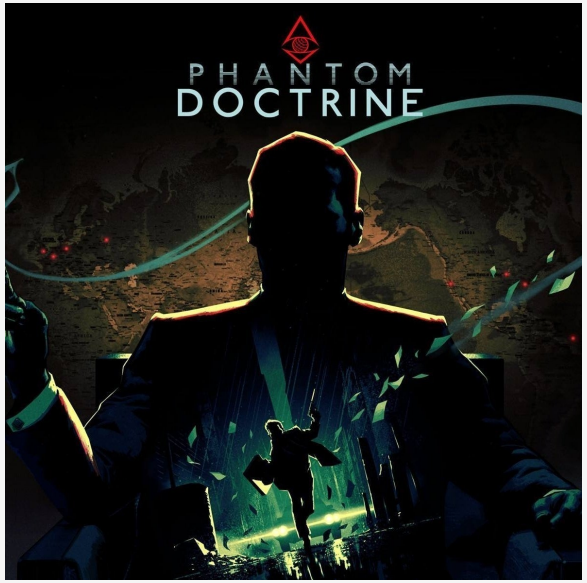

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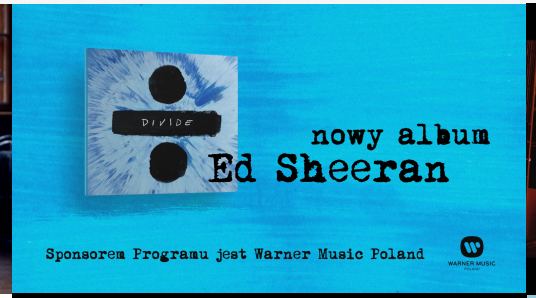

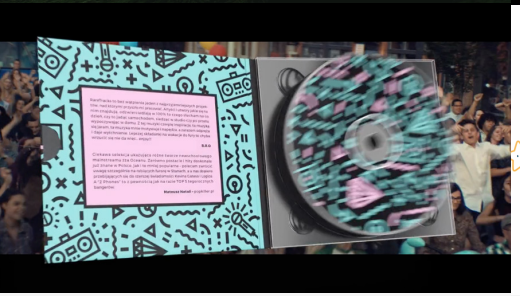

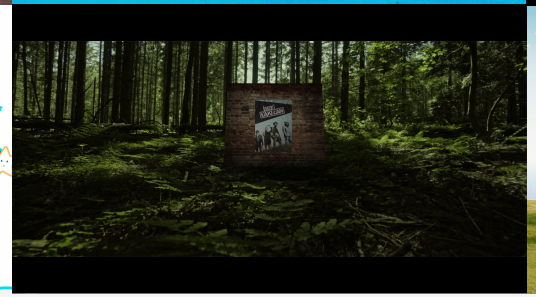

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Data-Driven Haptic Feedback in Avatar: Frontiers of Pandora

1. what
   - Haptic Feedback
   - AFOP Haptic Scope
2. why
   - Design Principles
   - Haptic Architectures
3. how
   - Content Pipeline
   - Runtime Processing
   - Audio-Based Haptic Effects

Closing Thoughts

Part 1:
what

Haptic Feedback
AVATAR
FRONTIERS OF PANDORA
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Haptic Feedback

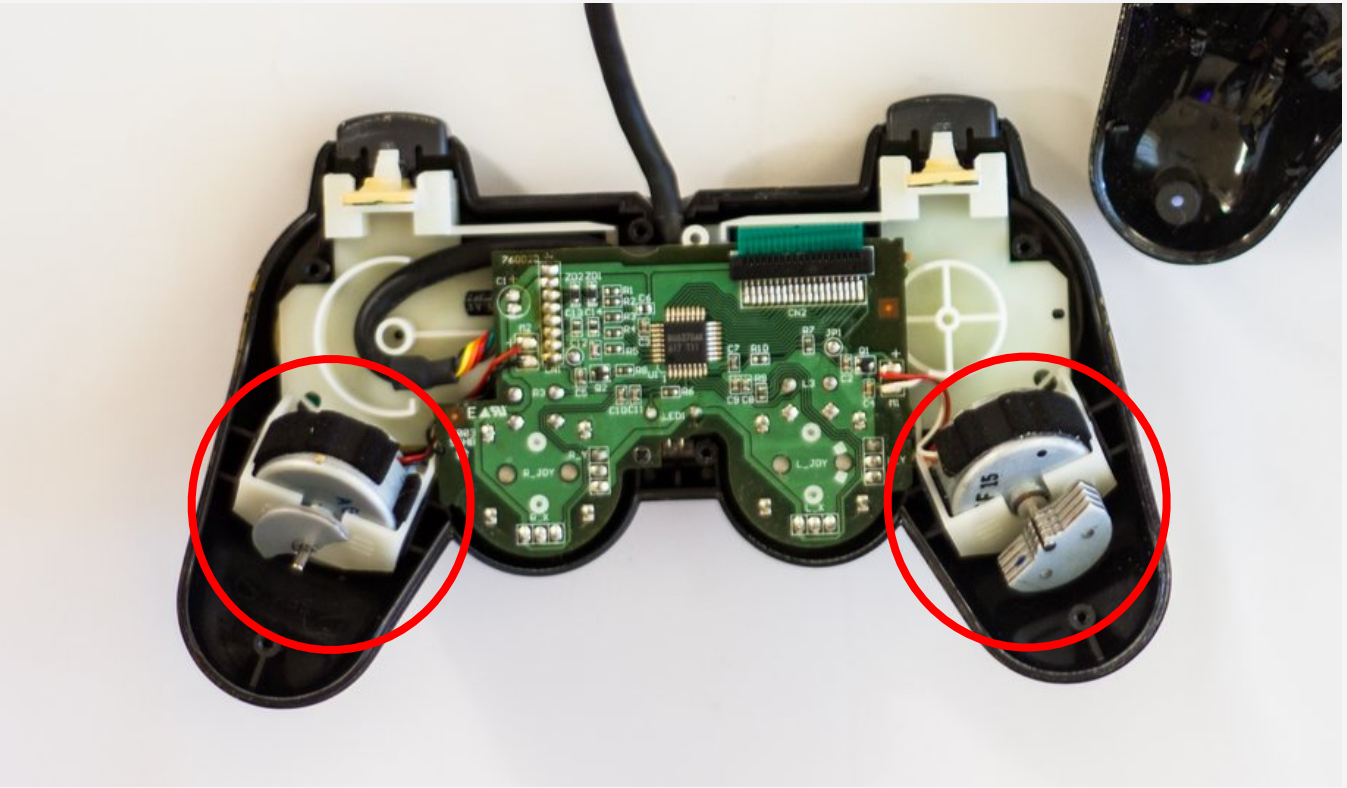
Visceral

Capable of nuance

Low barrier to entry

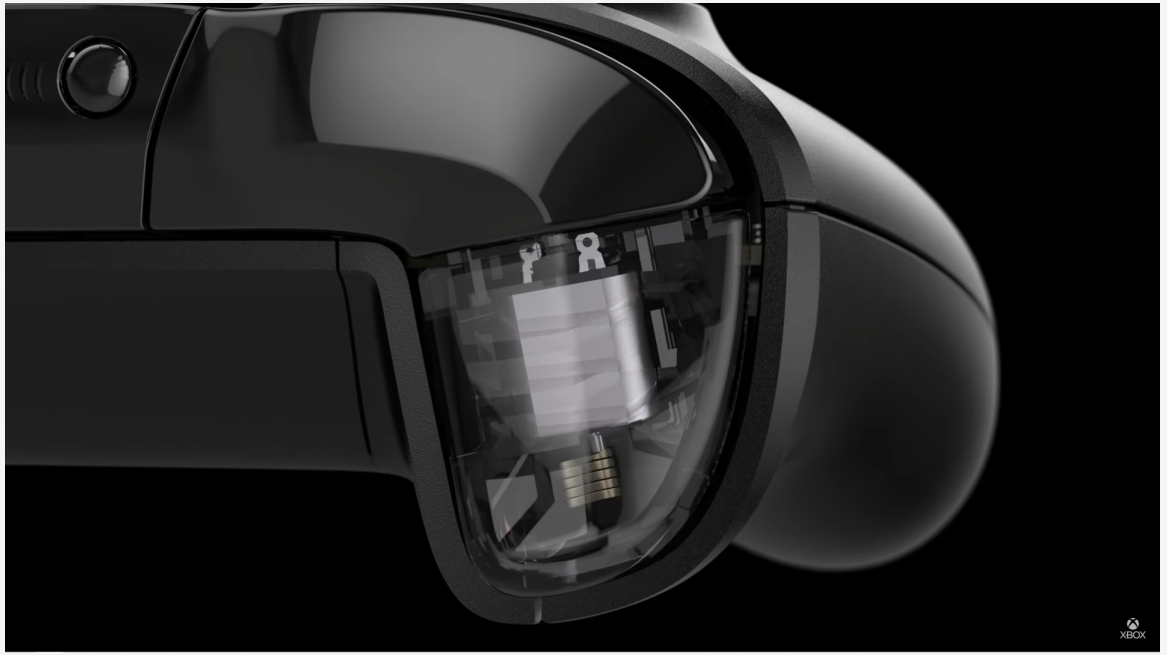
Multidisciplinary effort

Rumble



source: **ifixit.com**

Rumble

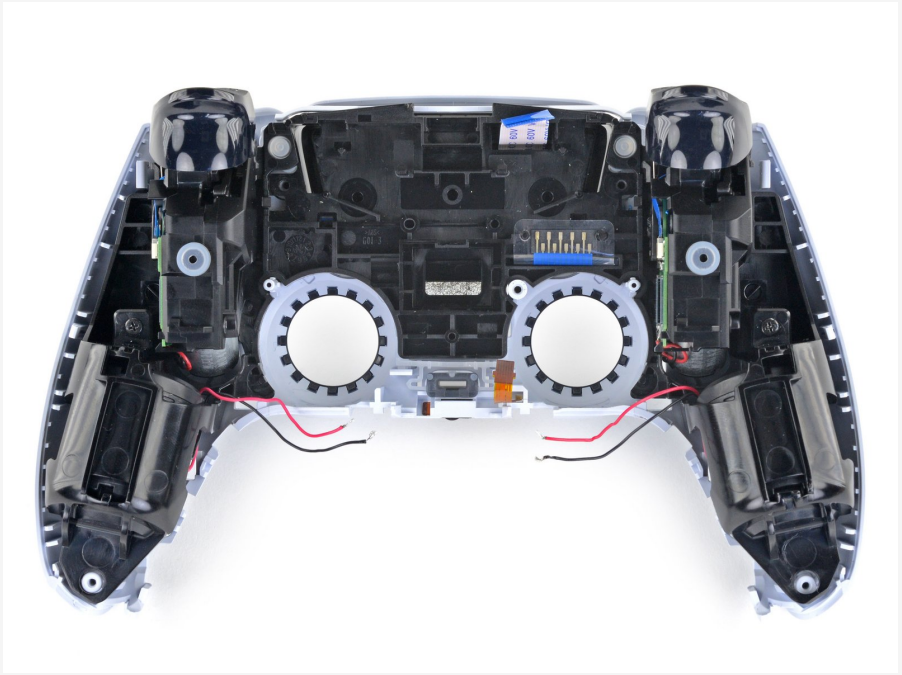


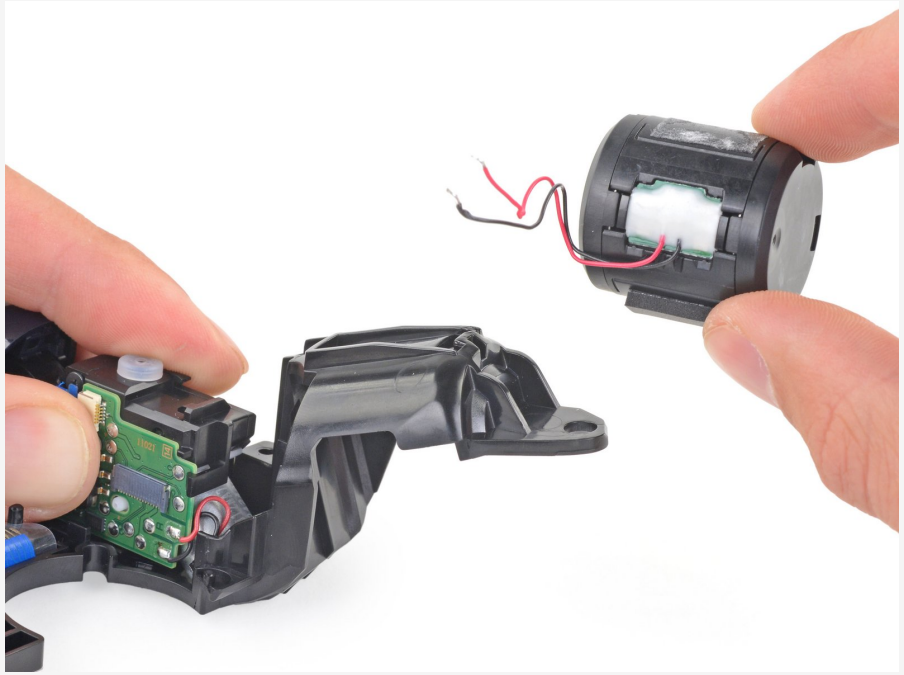
"Impulse Triggers"

source: **ifixit.com, Xbox YouTube Channel**

Audio-Based Haptics

"Advanced Haptics"

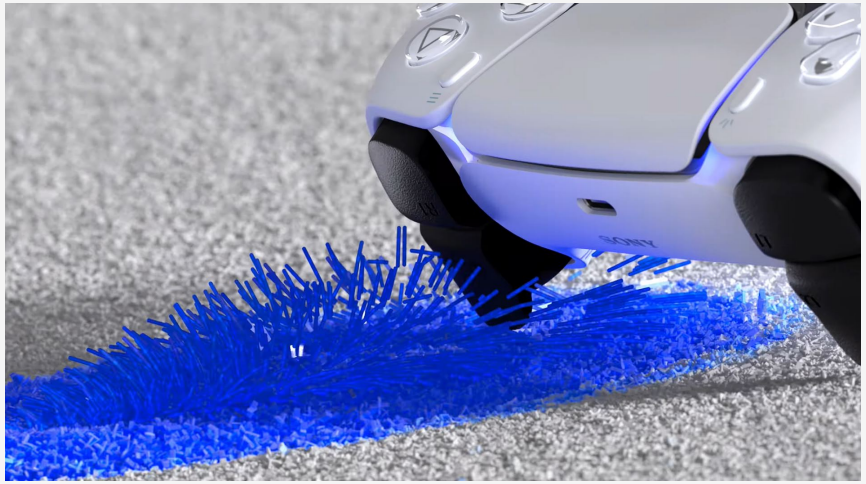


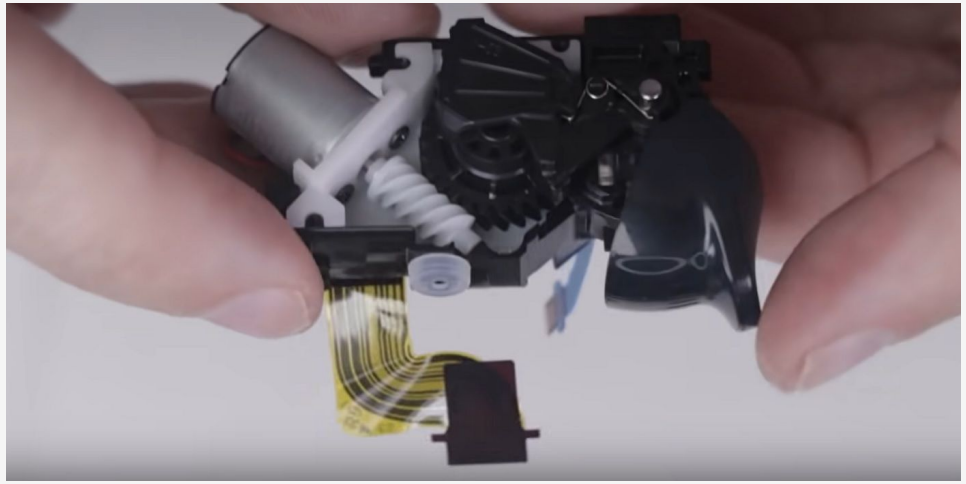


source: **ifixit.com**

Force Feedback

"Adaptive Triggers"





source: **PlayStation YouTube Channel**, **Screen Rant**

Rumble

motor-based
vibration effects

Audio-Based Haptics

new generation of haptic feedback
available on the DualSense controller

Haptic Event

gameplay cue

Haptic Effect

preset containing data about
a particular behavior of haptic devices

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Supported Types

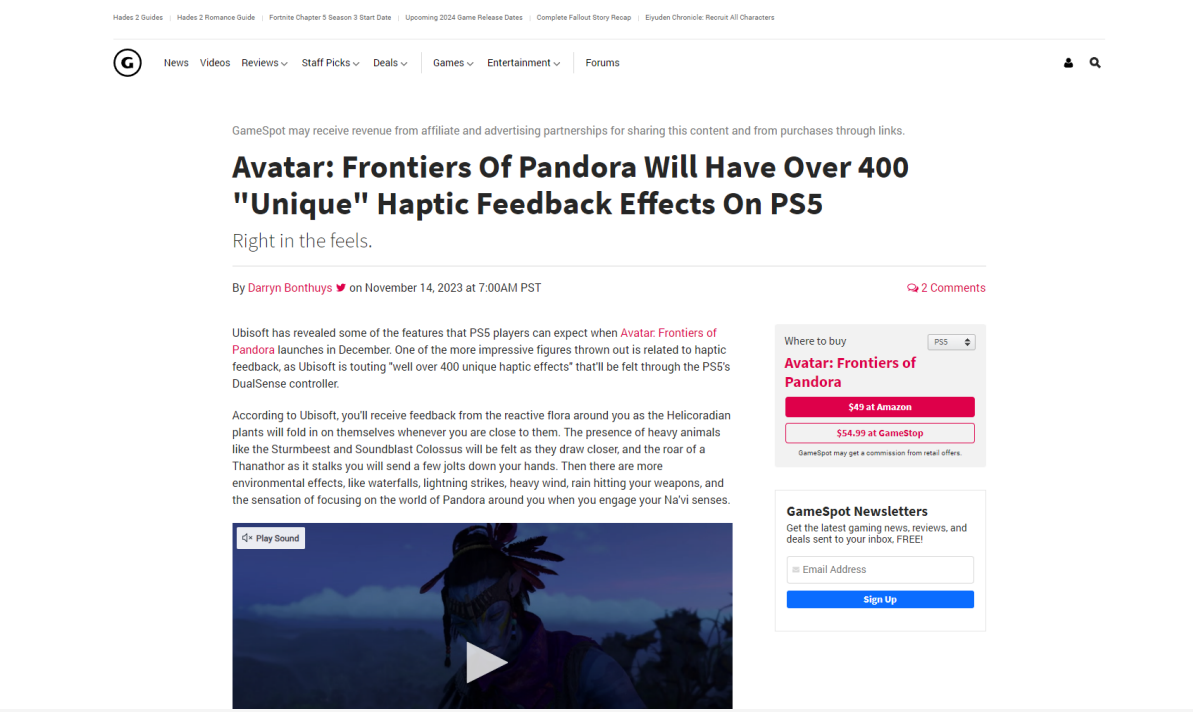
Audio-Based

4-Channel Rumble

2-Channel Rumble

+ Adaptive Triggers

Content



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Avatar: Frontiers Of Pandora Will Have Over 400 "Unique" Haptic Feedback Effects On PS5

Right in the feels.

By Darryn Bonthuys on November 14, 2023 at 7:00AM PST

2 Comments

Ubisoft has revealed some of the features that PS5 players can expect when Avatar: Frontiers of Pandora launches in December. One of the more impressive figures thrown out is related to haptic feedback, as Ubisoft is touting "well over 400 unique haptic effects" that'll be felt through the PS5's DualSense controller.

According to Ubisoft, you'll receive feedback from the reactive flora around you as the Helicoradian plants will fold in on themselves whenever you are close to them. The presence of heavy animals like the Sturmbeest and Soundblast Colossus will be felt as they draw closer, and the roar of a Thanathor as it stalks you will send a few jolts down your hands. Then there are more environmental effects, like waterfalls, lightning strikes, heavy wind, rain hitting your weapons, and the sensation of focusing on the world of Pandora around you when you engage your Na'vi senses.

Play Sound

Where to buy PS5

Avatar: Frontiers of Pandora

$49 at Amazon

$54.99 at GameStop

GameSpot may get a commission from retail offers.

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Content

>1000 effects

~250 events

Team Size

Tech

1 Gameplay Programmer

1 Audio Programmer

1 Game Designer

+ occasional support from the Engine team

Content

1 Gameplay Programmer

1 Game Designer

(part time)

+ occasional support from other Game Designers

Part 2:
why

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First, do no harm

Haptics should never be a nuisance

We are not a tech demo

Vibration Intensity - Traversal	10
Vibration Intensity - Weapons, Tools, and Attacks	10
Vibration Intensity - Damage and Death	10
Vibration Intensity - Environment	10
Vibration Intensity - Interactions	10
Vibration Intensity - Gathering	10
Vibration Intensity - Menus	10
Vibration Intensity - Cinematics	10
Vibration Intensity - Background Effects	10

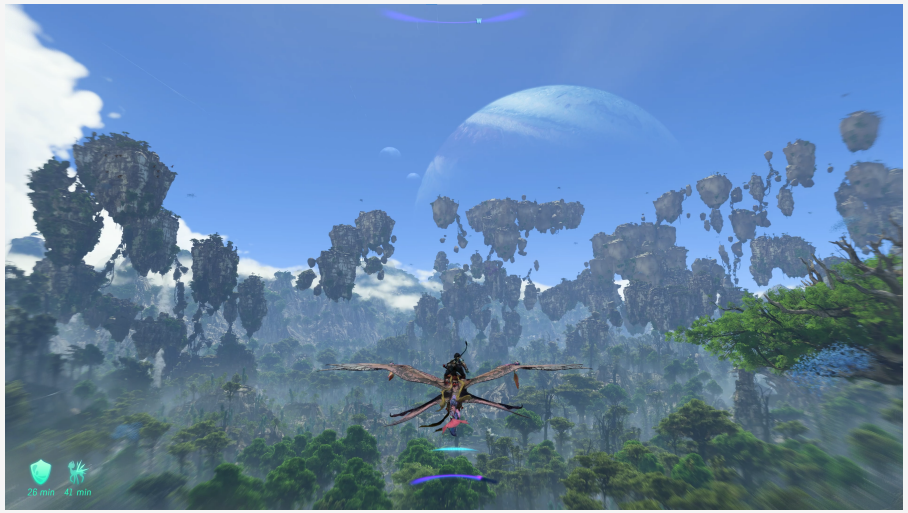
Vibration Intensity - Menus

Select the vibration intensity of effects related to browsing and interacting with menus.

Haptics = Physical Link

Would my avatar perceive this effect?

Haptics = Physical Link



21.1 KHz
5.5 KHz
1.5 KHz
352 Hz
70 Hz
1 Hz

Clear Association

Follow the Audio

Play in Sync

Dissipate Quickly

Haptic System Architecture

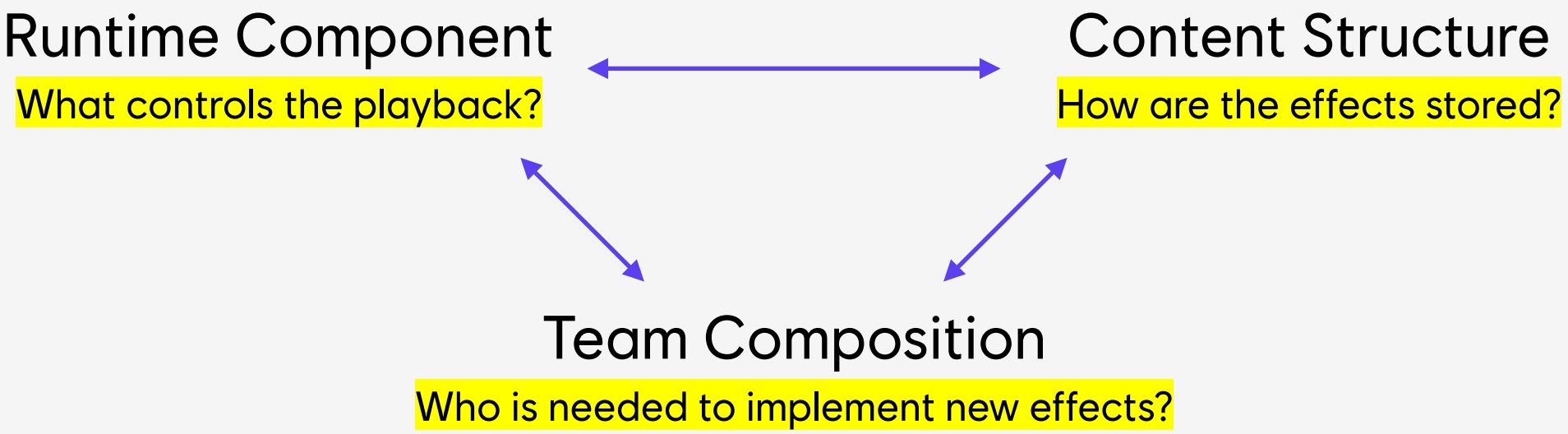
Haptic System Architecture

What is a haptic system architecture

Example architectures

Architecture in AFOP

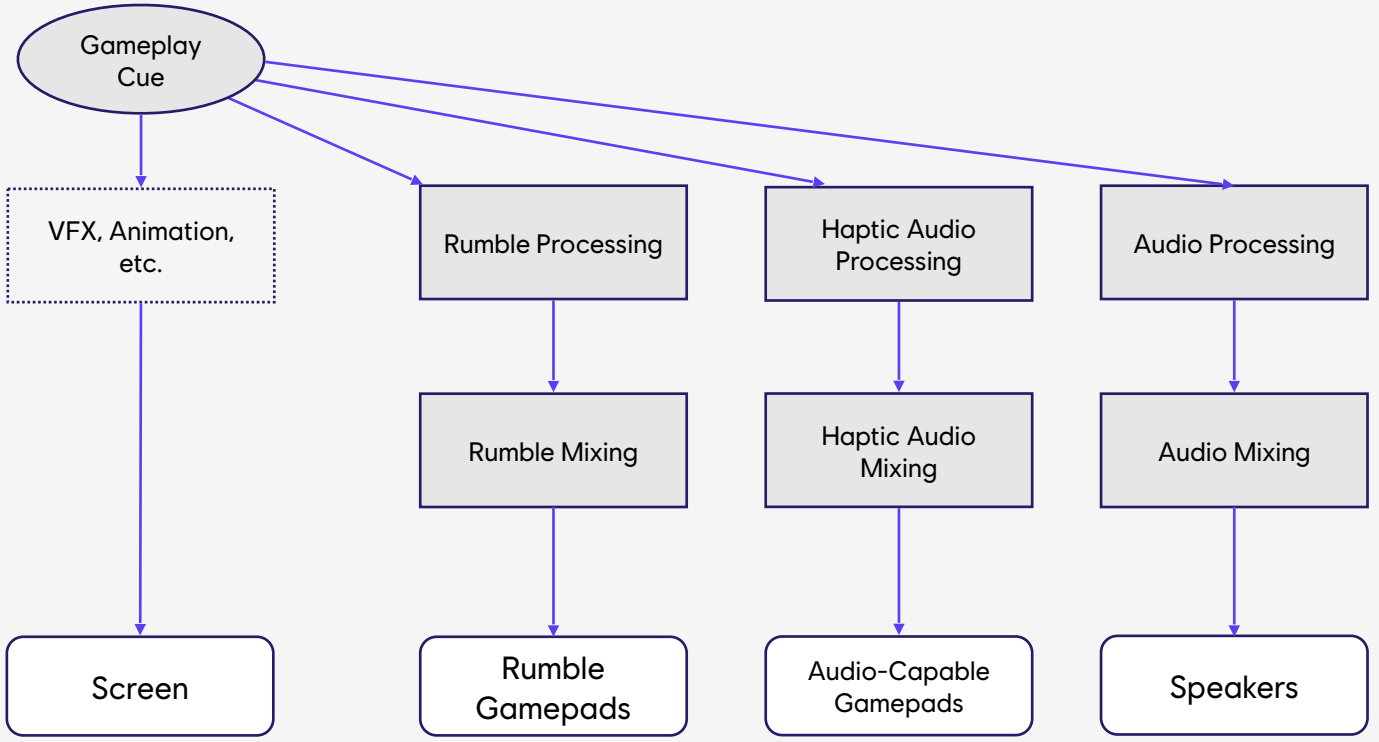
Haptic System Architecture



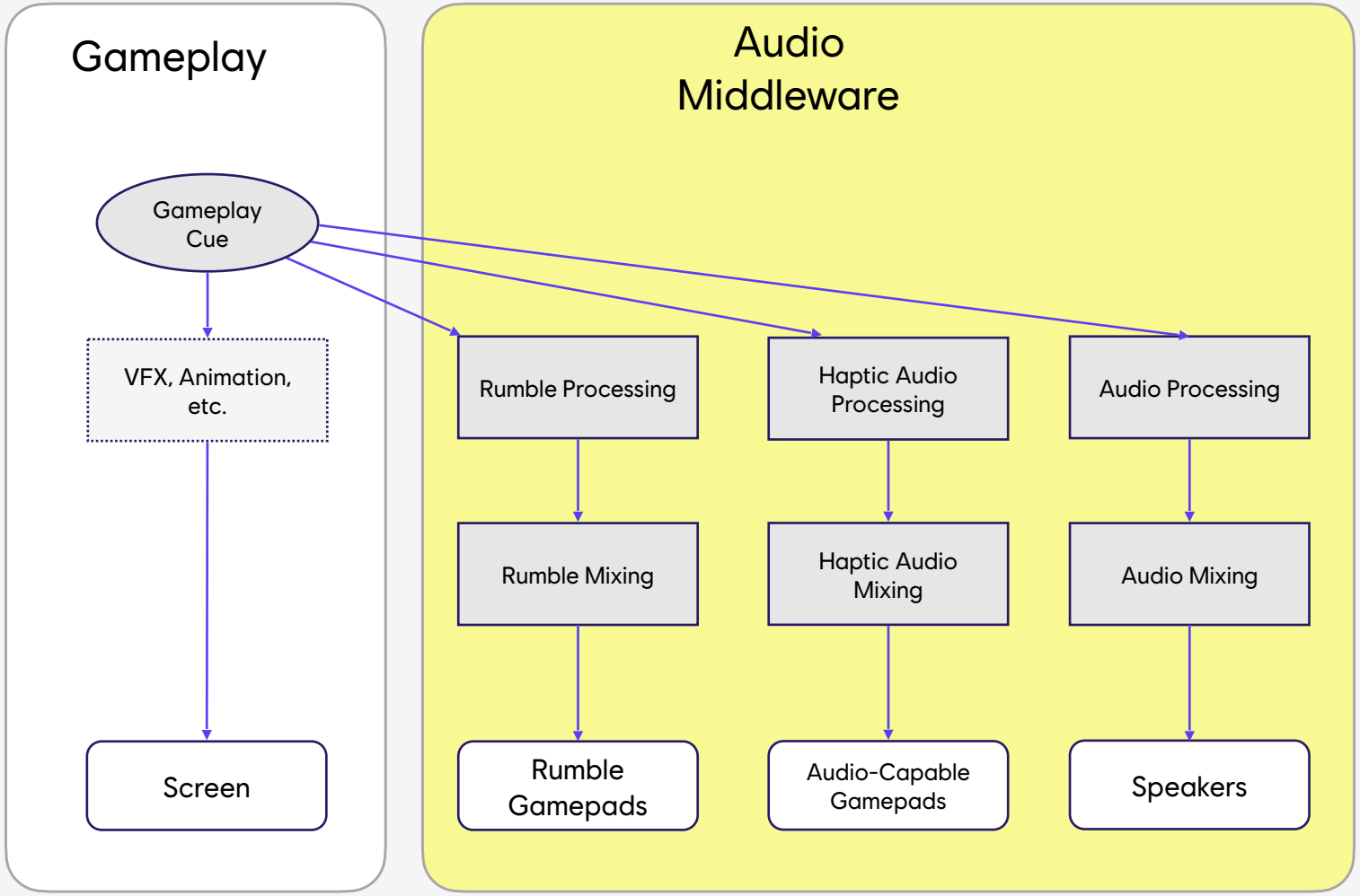
Example Architectures

	Rumble	**Audio Haptics** (PS5-exclusive)	**Multiplatform Audio-Driven**	**Multiplatform Mixed**	**Multiplatform Data-Driven**
Runtime Component	Gameplay	Audio Middleware	Audio Middleware + Plugins	Gameplay + Audio Middleware	Gameplay
Content Structure	Curve Data	Audio Files	Audio Files + Curve Data	Curve Data + Audio Files	Curve Data + Audio Files
Team Composition	Gameplay Code + Game Design	Sound Design	Sound Design	Gameplay Code + Game Design + Sound Design	Gameplay Code + Game Design

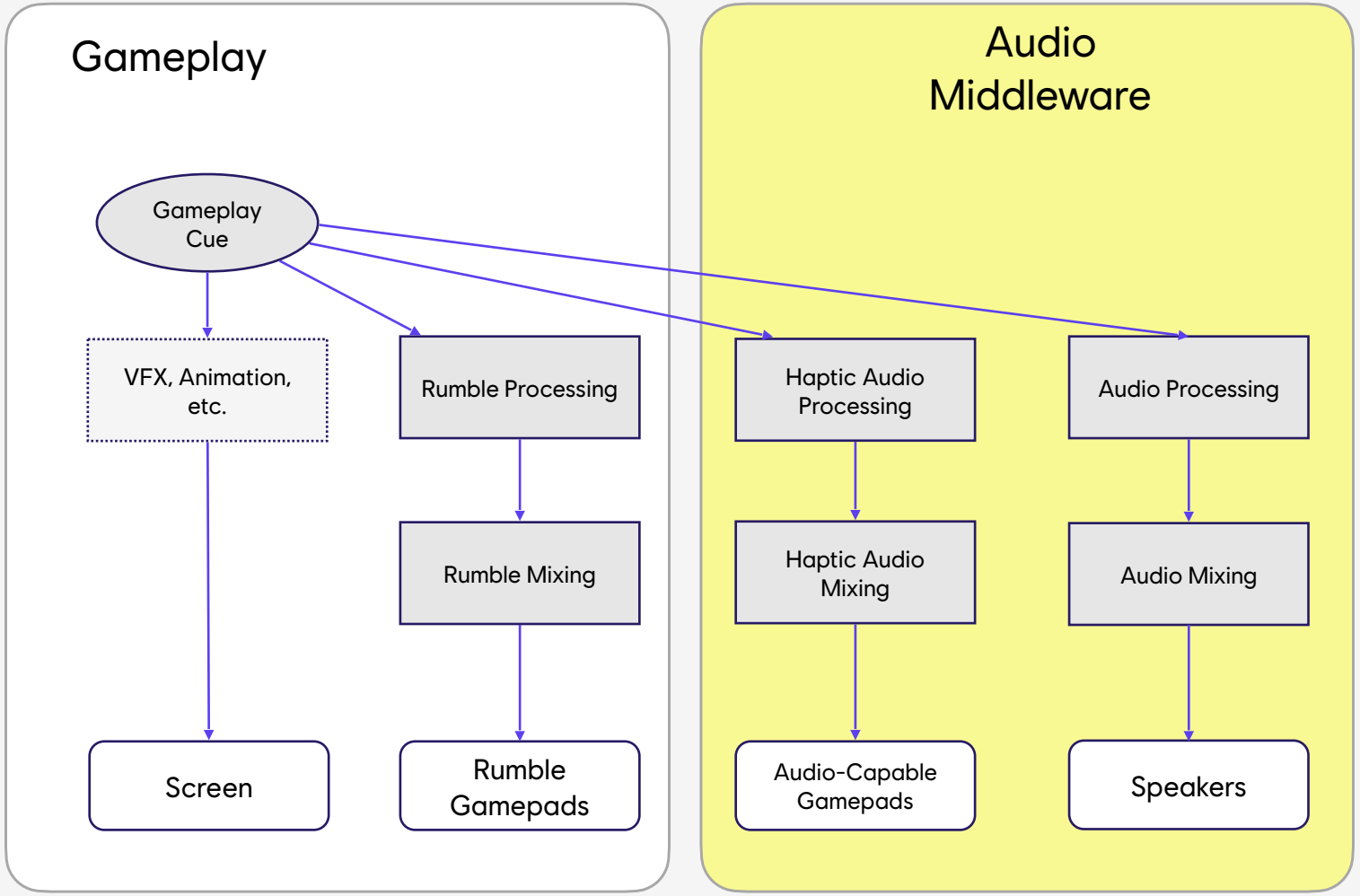
Haptic System Architecture



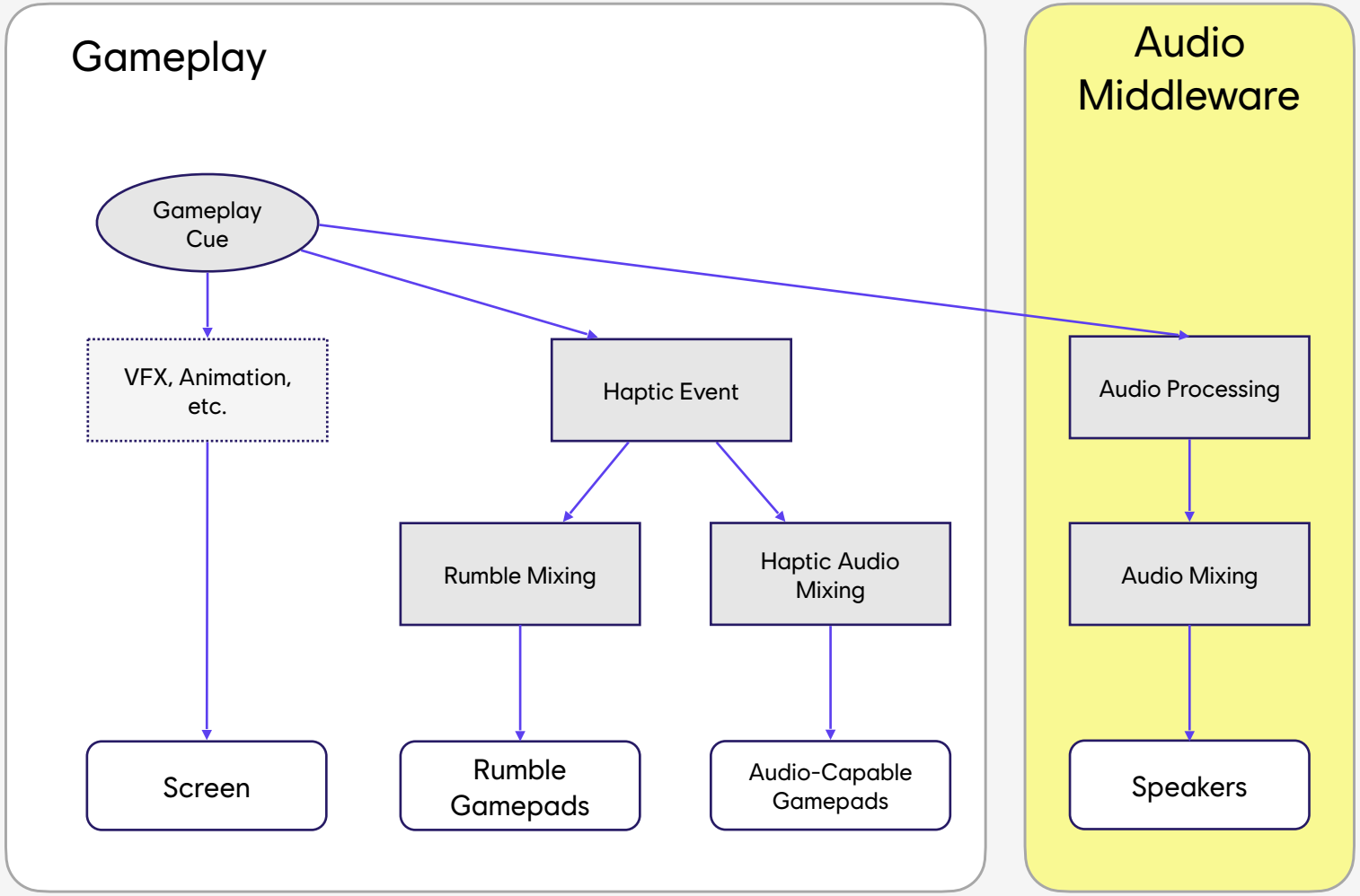
Audio-Driven Haptics



Mixed Haptics



Data-Driven Haptics



Choosing an Architecture

Team Composition

Tech Stack

There’s no “One size fits all”

Multiplatform Architectures

Audio-Driven	Mixed	Data-Driven
One team handles both Rumble and Audio-Based Haptics	Each team sticks to its domain	One team handles both Rumble and Audio-Based Haptics
Audio designers need to onboard to haptic tech	Audio designers need to onboard to audio-based haptic tech	Gameplay team needs to learn basics of audio
Longer iteration loop	Longer iteration loop	Gameplay systems need to expand to support Audio-Based Haptics
Audio middleware plugin required	Possible mismatch between Rumble and Audio-Based Haptics	Possible mismatch between Haptics and game audio

Main Reasons

Team Composition

Snowdrop Engine

Shorter Iteration Loop

Part 3:
how

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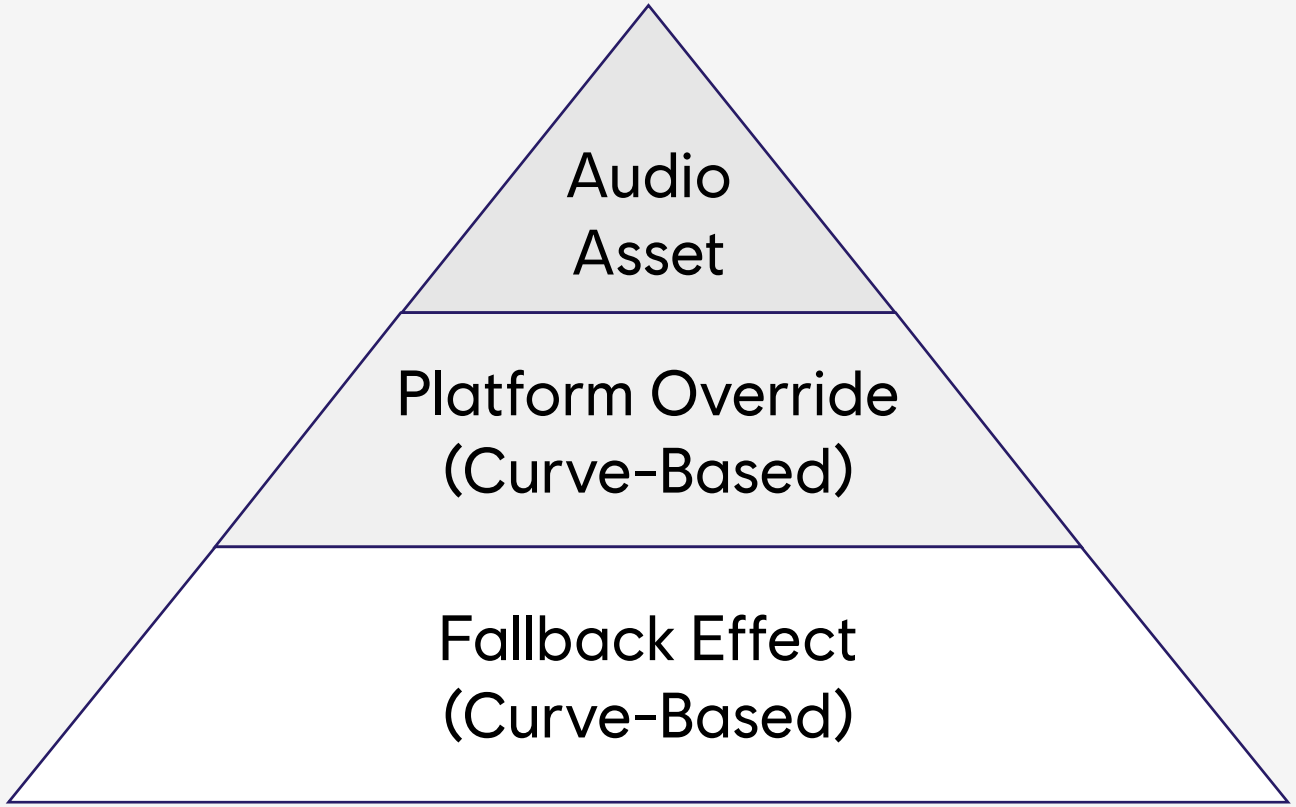
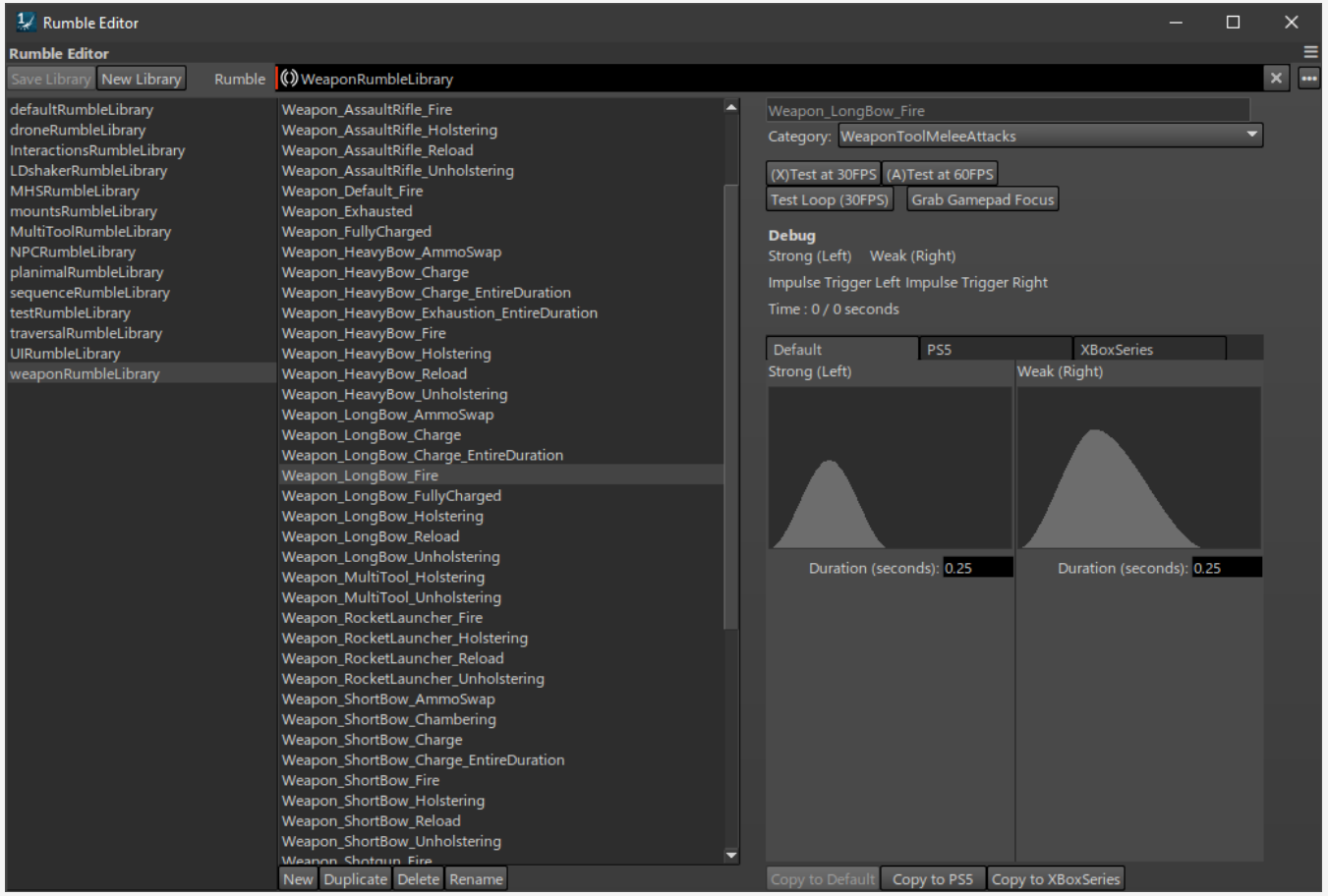
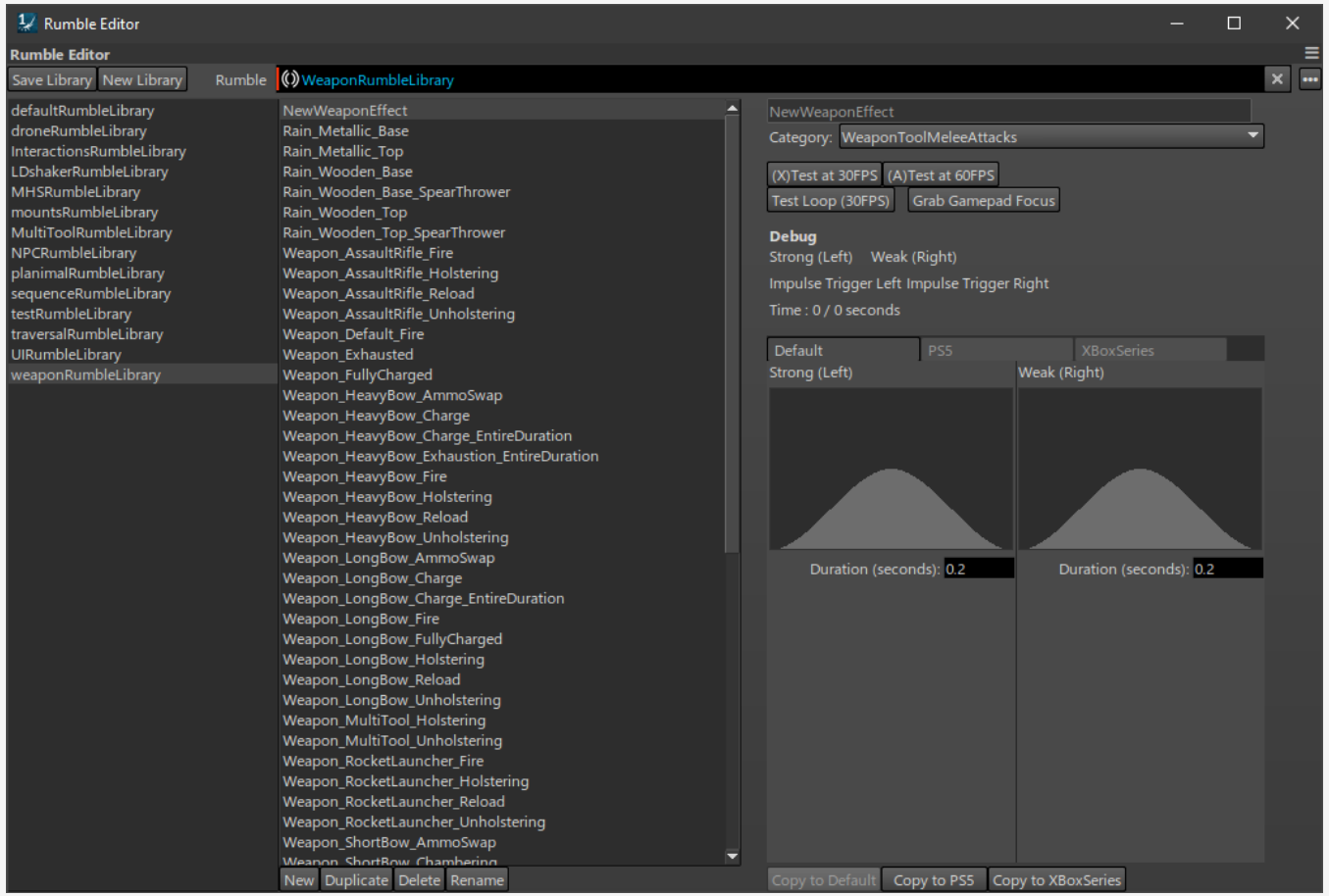
Haptic Effect Data



Editor


Rumble Editor
Rumble Editor
Save Library
New Library
Rumble
WeaponRumbleLibrary
defaultRumbleLibrary
droneRumbleLibrary
InteractionsRumbleLibrary
LDshakerRumbleLibrary
MHSRumbleLibrary
mountsRumbleLibrary
MultiToolRumbleLibrary
NPCRumbleLibrary
planimalRumbleLibrary
sequenceRumbleLibrary
testRumbleLibrary
traversalRumbleLibrary
UIRumbleLibrary
weaponRumbleLibrary
Weapon_AssaultRifle_Fire
Weapon_AssaultRifle_Holstering
Weapon_AssaultRifle_Reload
Weapon_AssaultRifle_Unholstering
Weapon_Default_Fire
Weapon_Exhausted
Weapon_FullyCharged
Weapon_HeavyBow_AmmoSwap
Weapon_HeavyBow_Charge
Weapon_HeavyBow_Charge_EntireDuration
Weapon_HeavyBow_Exhaustion_EntireDuration
Weapon_HeavyBow_Fire
Weapon_HeavyBow_Holstering
Weapon_HeavyBow_Reload
Weapon_HeavyBow_Unholstering
Weapon_LongBow_AmmoSwap
Weapon_LongBow_Charge
Weapon_LongBow_Charge_EntireDuration
Weapon_LongBow_Fire
Weapon_LongBow_FullyCharged
Weapon_LongBow_Holstering
Weapon_LongBow_Reload
Weapon_LongBow_Unholstering
Weapon_MultiTool_Holstering
Weapon_MultiTool_Unholstering
Weapon_RocketLauncher_Fire
Weapon_RocketLauncher_Holstering
Weapon_RocketLauncher_Reload
Weapon_RocketLauncher_Unholstering
Weapon_ShortBow_AmmoSwap
Weapon_ShortBow_Chambering
Weapon_ShortBow_Charge
Weapon_ShortBow_Charge_EntireDuration
Weapon_ShortBow_Fire
Weapon_ShortBow_Holstering
Weapon_ShortBow_Reload
Weapon_ShortBow_Unholstering
Weapon_Shotgun_Fire
New
Duplicate
Delete
Rename
Weapon_LongBow_Fire
Category:
WeaponToolMeleeAttacks
(X)Test at 30FPS
(A)Test at 60FPS
Test Loop (30FPS)
Grab Gamepad Focus
Debug
Strong (Left)
Weak (Right)
Impulse Trigger Left
Impulse Trigger Right
Time : 0 / 0 seconds
Default
PS5
XBoxSeries
Strong (Left)
Weak (Right)
Duration (seconds):
0.25
Duration (seconds):
0.25
Copy to Default
Copy to PS5
Copy to XBoxSeries

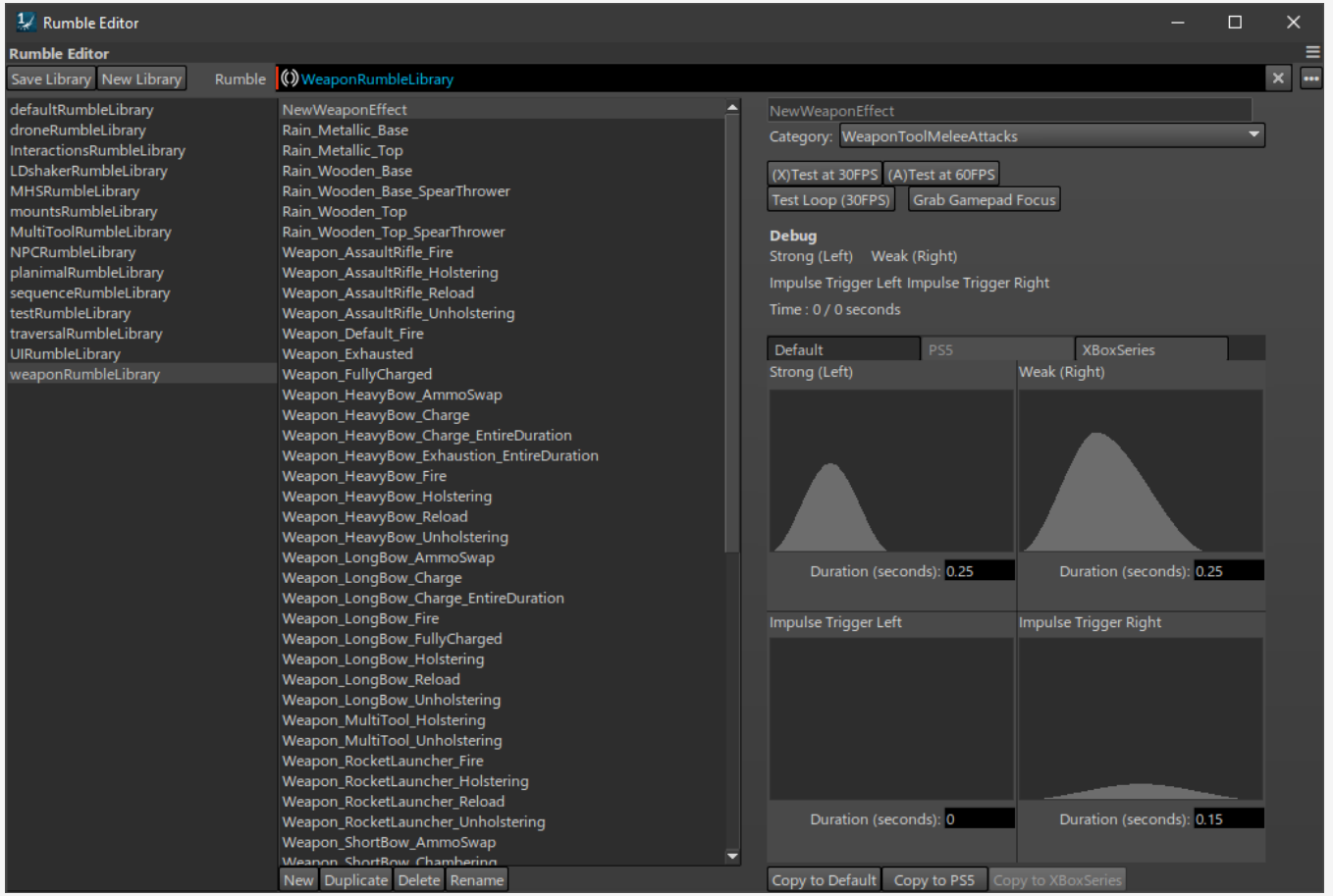
1. Fallback Effect



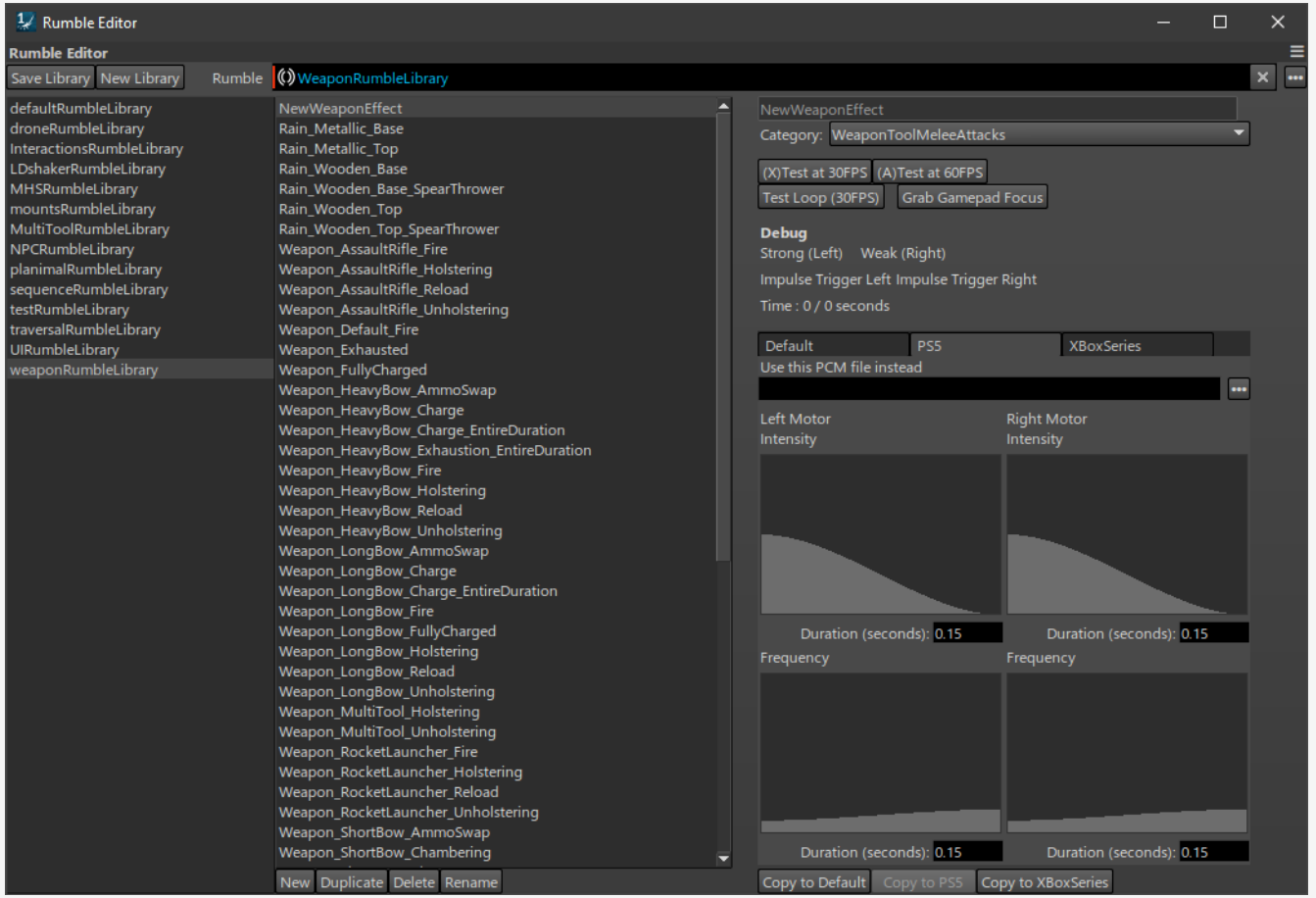
Left Actuator Frequency	Right Actuator Frequency
60 Hz	120 Hz

+ Latency Compensation

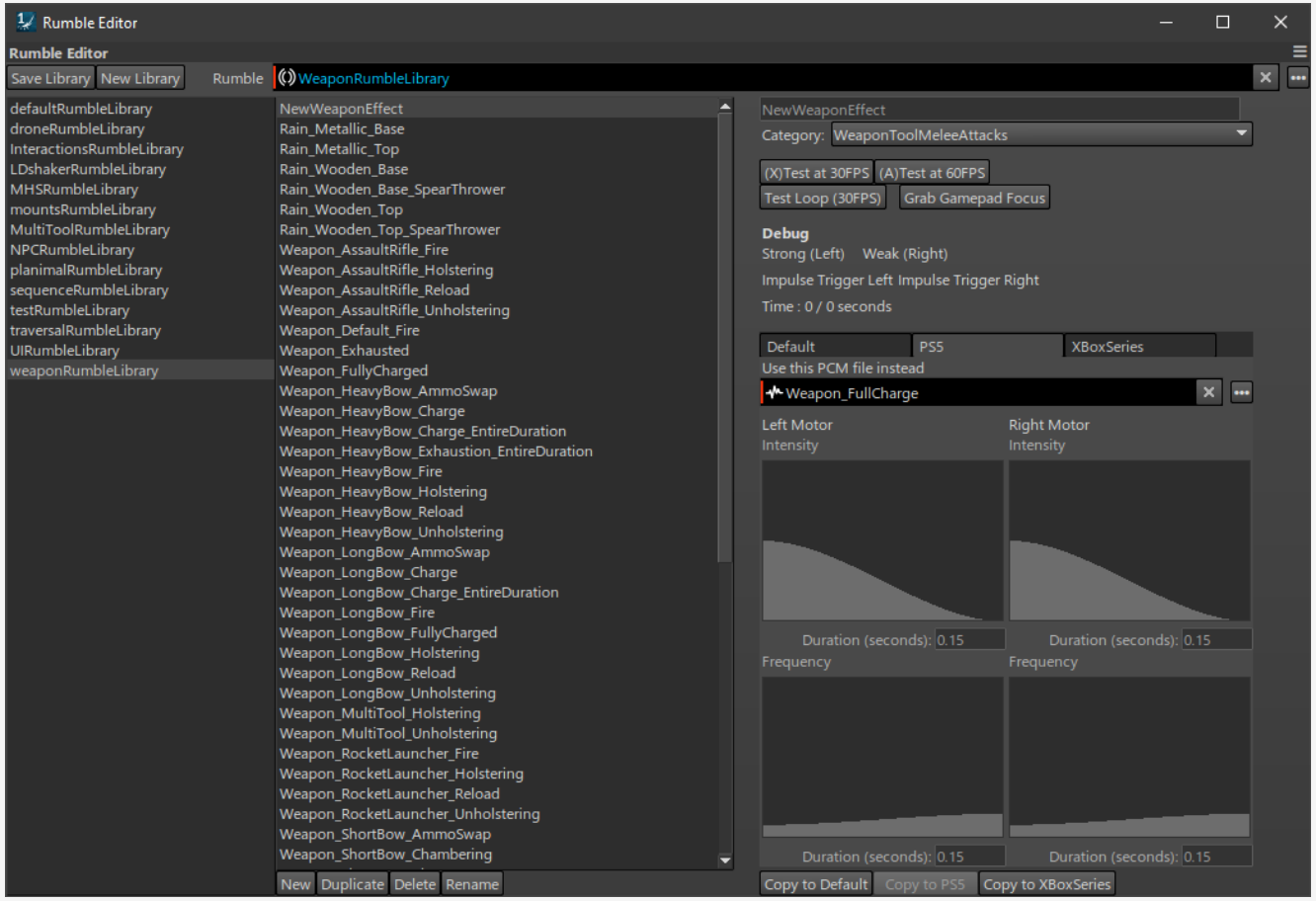
2. Xbox Override

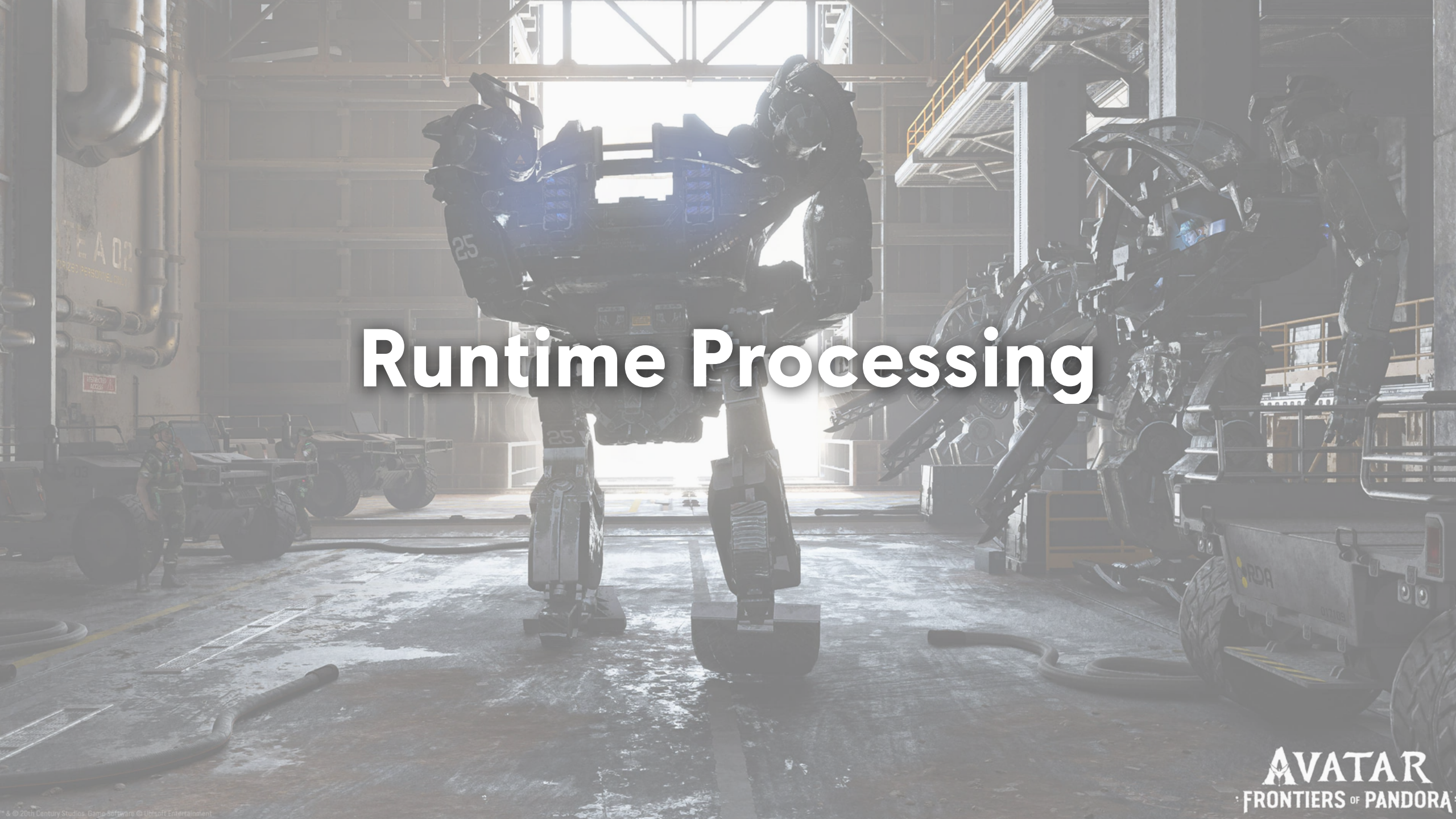


3. DualSense Override



4. Bespoke Audio




Runtime Processing
AVATAR
FRONTIERS OF PANDORA

Runtime Processing

Playback Control + Pre-Mix

Node Graphs + Code

Positional and Orientational Processing

Mixing

Node Graphs

Optimization Strategies

Prop Art, Tech Art, VFX	→	Shaders
Audio	→	Middleware
Haptics	→	???

Orientational Effects

Effects Are Already Multi-Channel

Rumble Channels Are Not Interchangeable

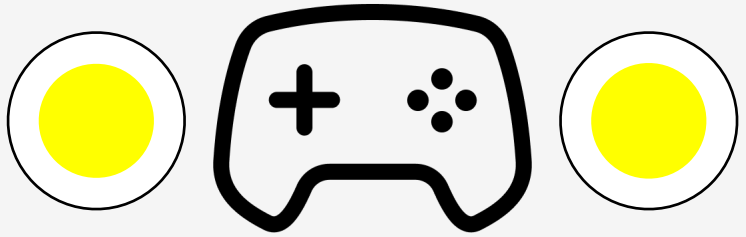
Mixing Audio Channels Could Get Really Complex

Don’t Shuffle Channels - Ever

Orientational Effects

Left

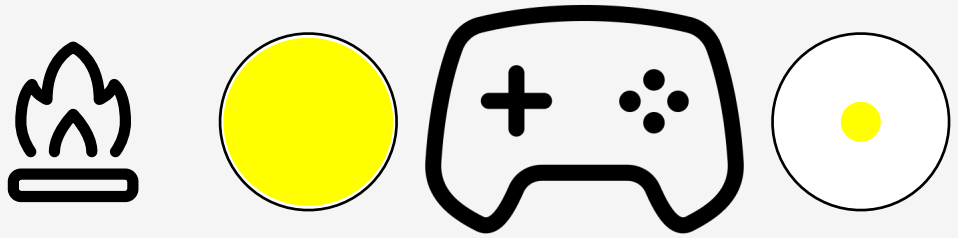
Right



Orientational Effects

Left

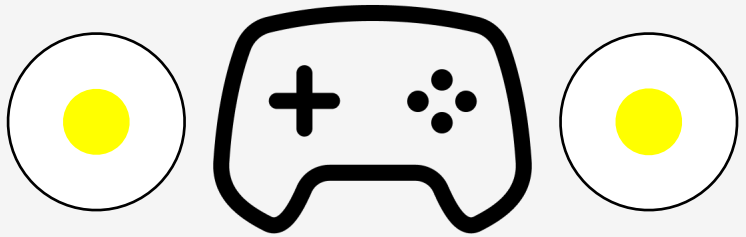
Right



Orientational Effects

Left

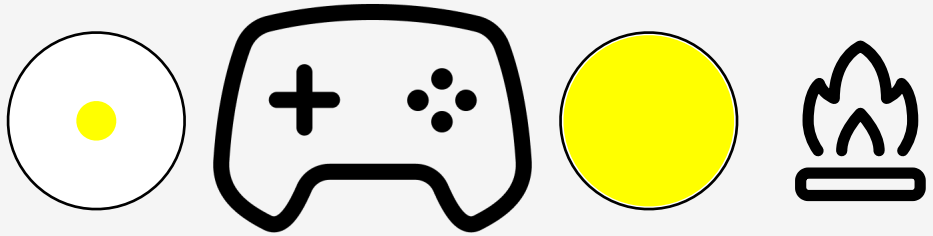
Right



Orientational Effects

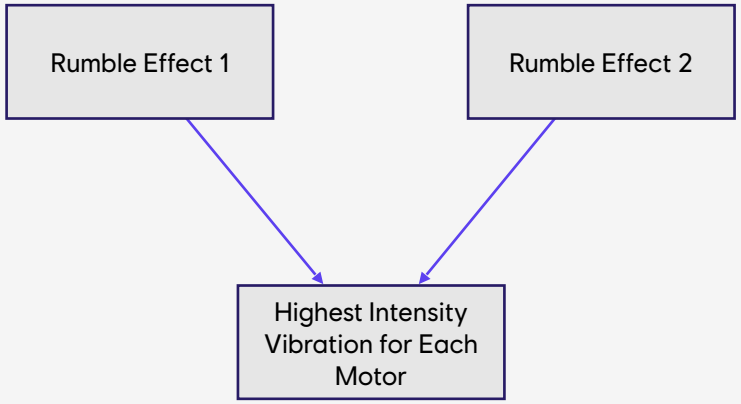
Left

Right

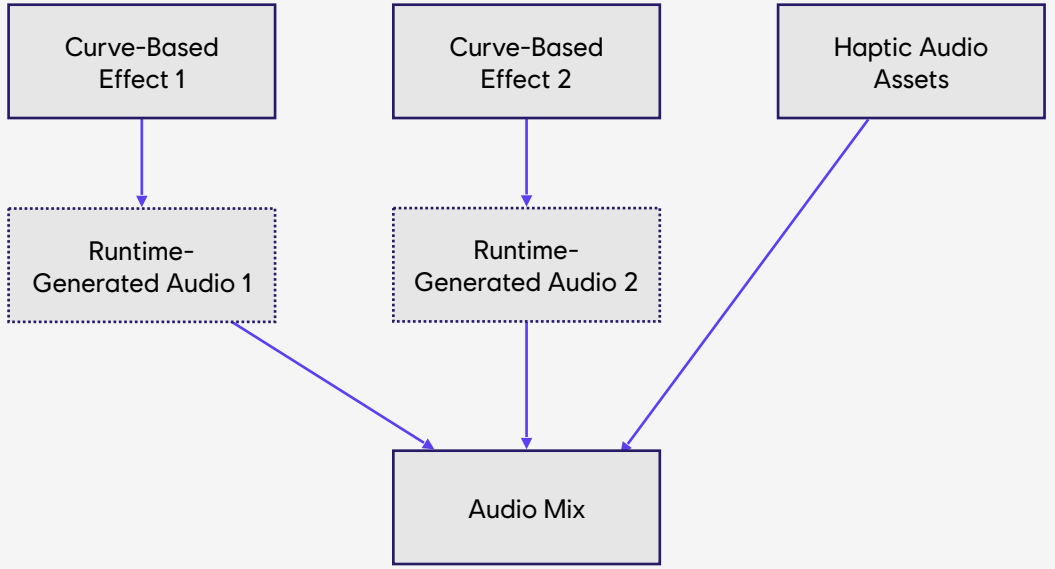


Mixing

Rumble Mixing



Haptics Audio Mixing



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Creating Haptic Audio

Based on Game Audio

Synthesized

Basic Audio Filters

Low-Pass

De-Noise

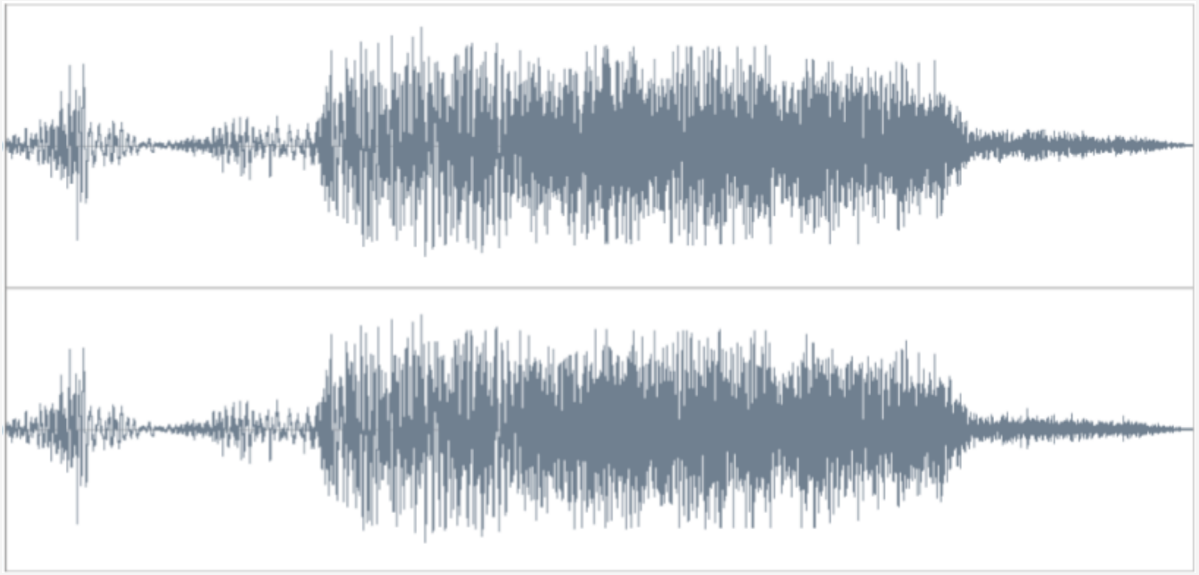
EQ

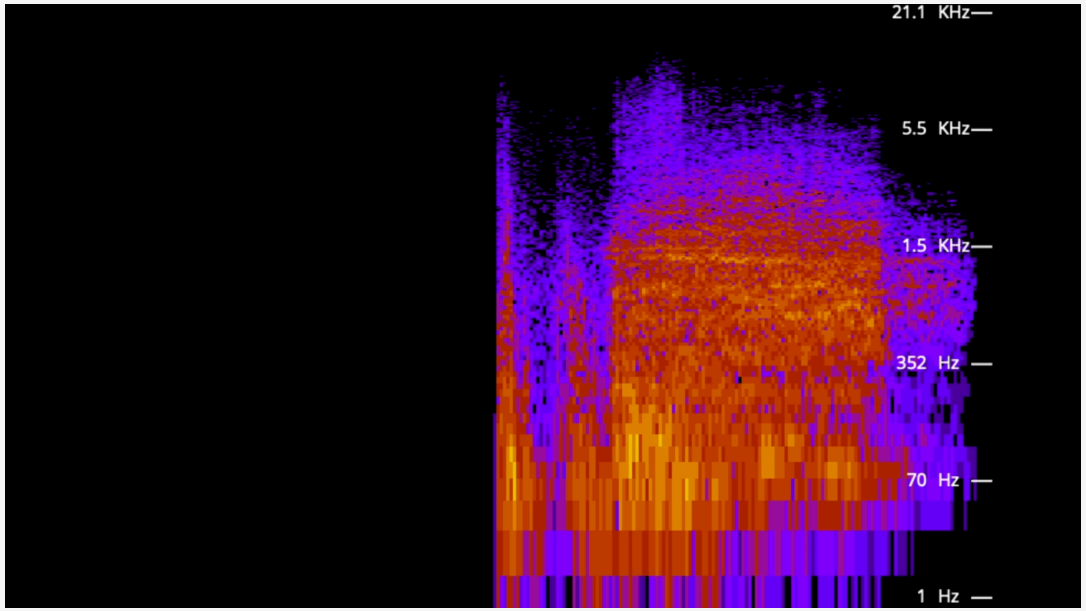
Impact

Envelope

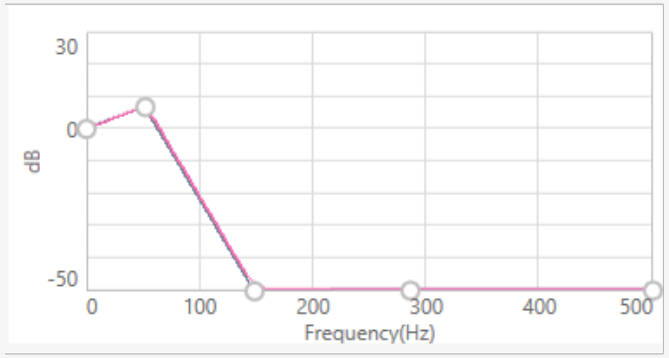
Haptic Audio Based on Game Audio Example: Banshee Screech

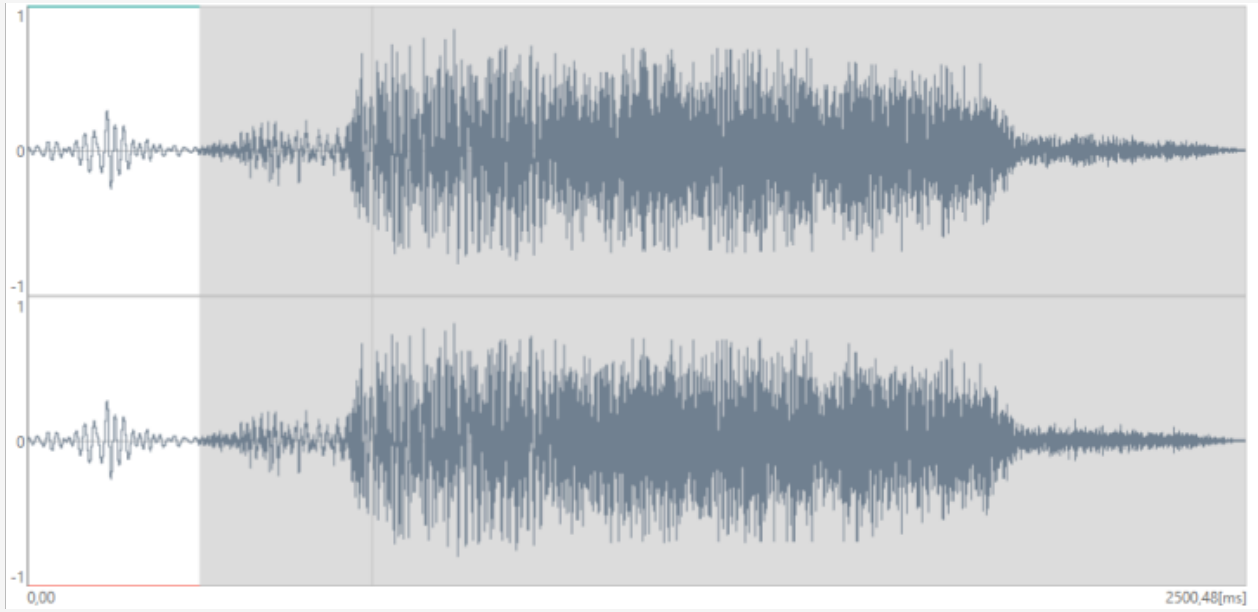
1. Source SFX



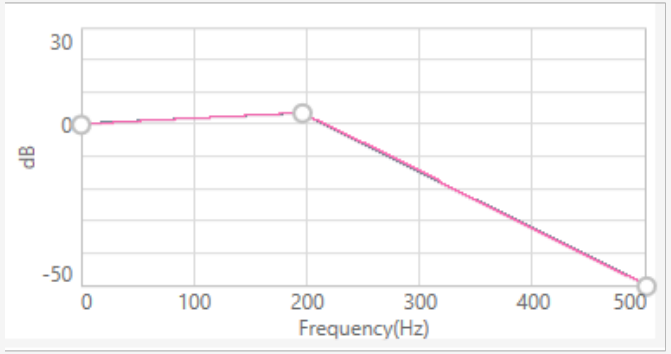


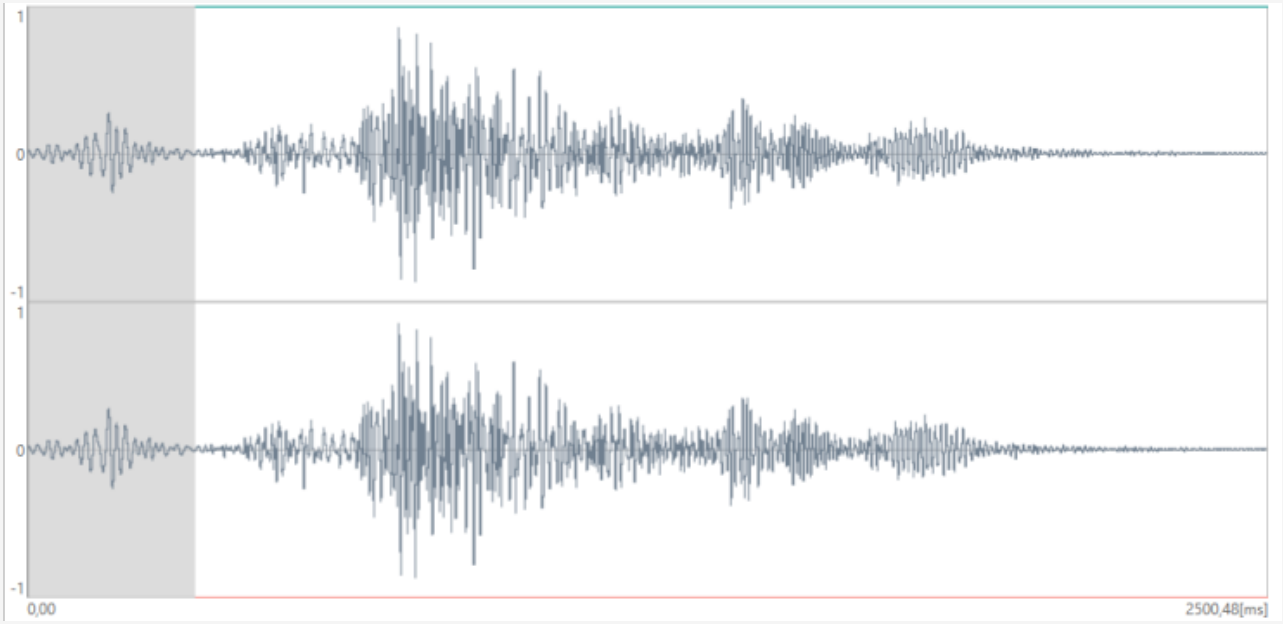
2. Apply EQ to the Wing Flap



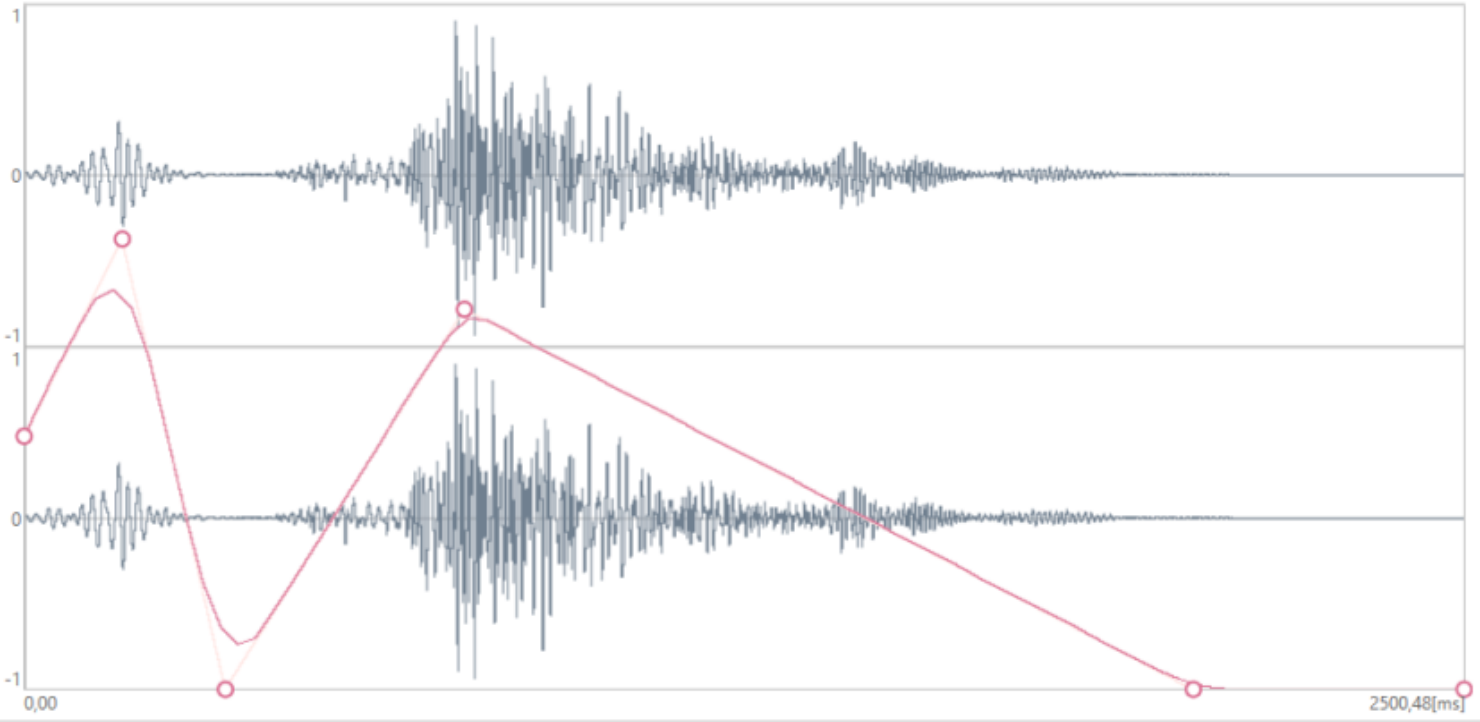


3. Apply EQ to the Screech

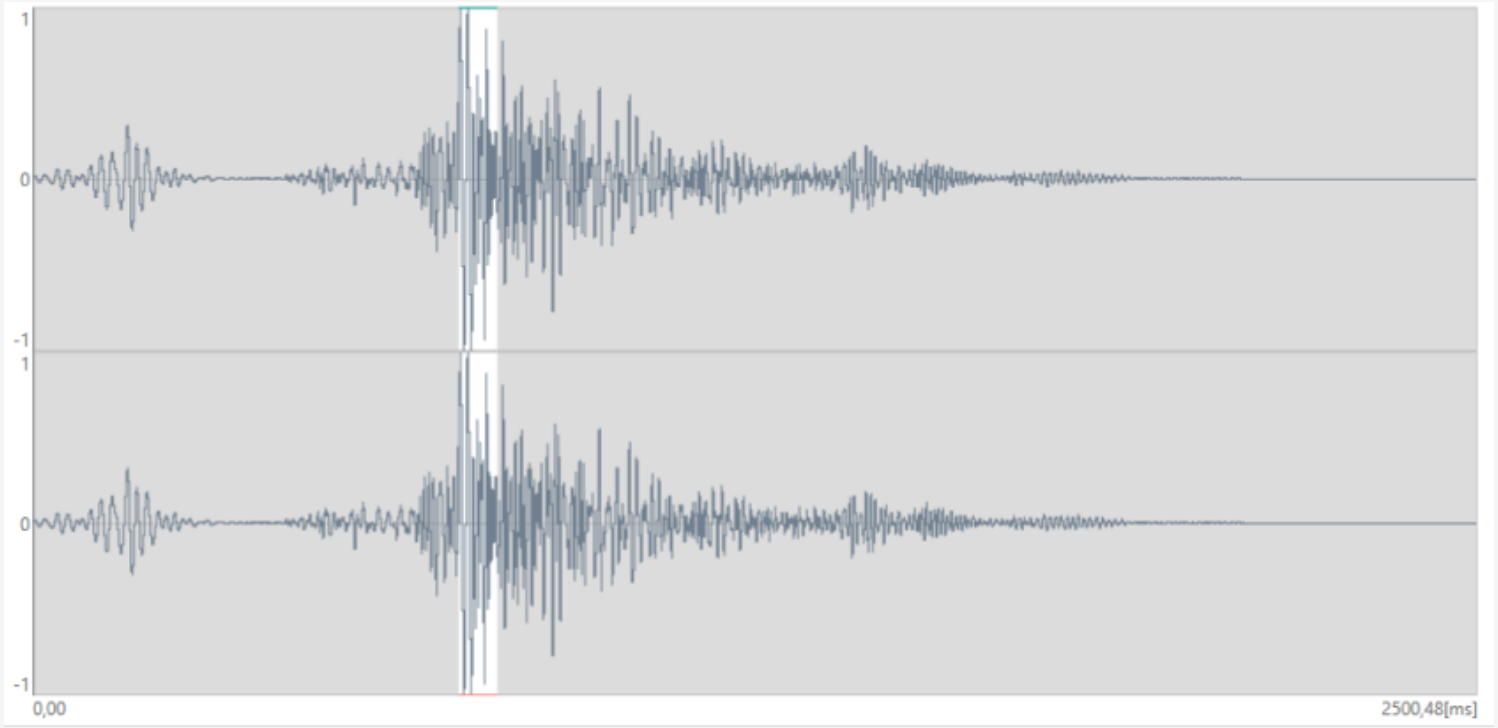




4. Add Envelope

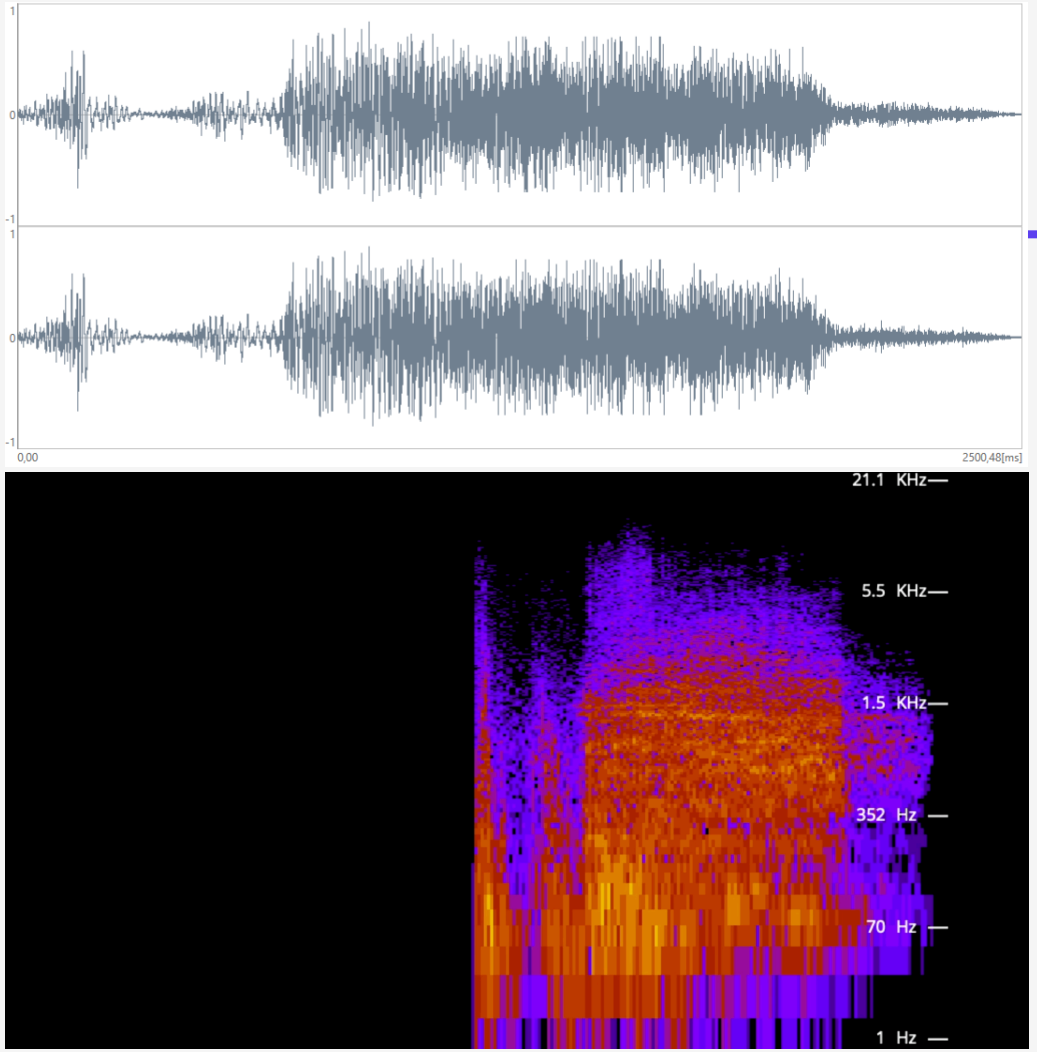


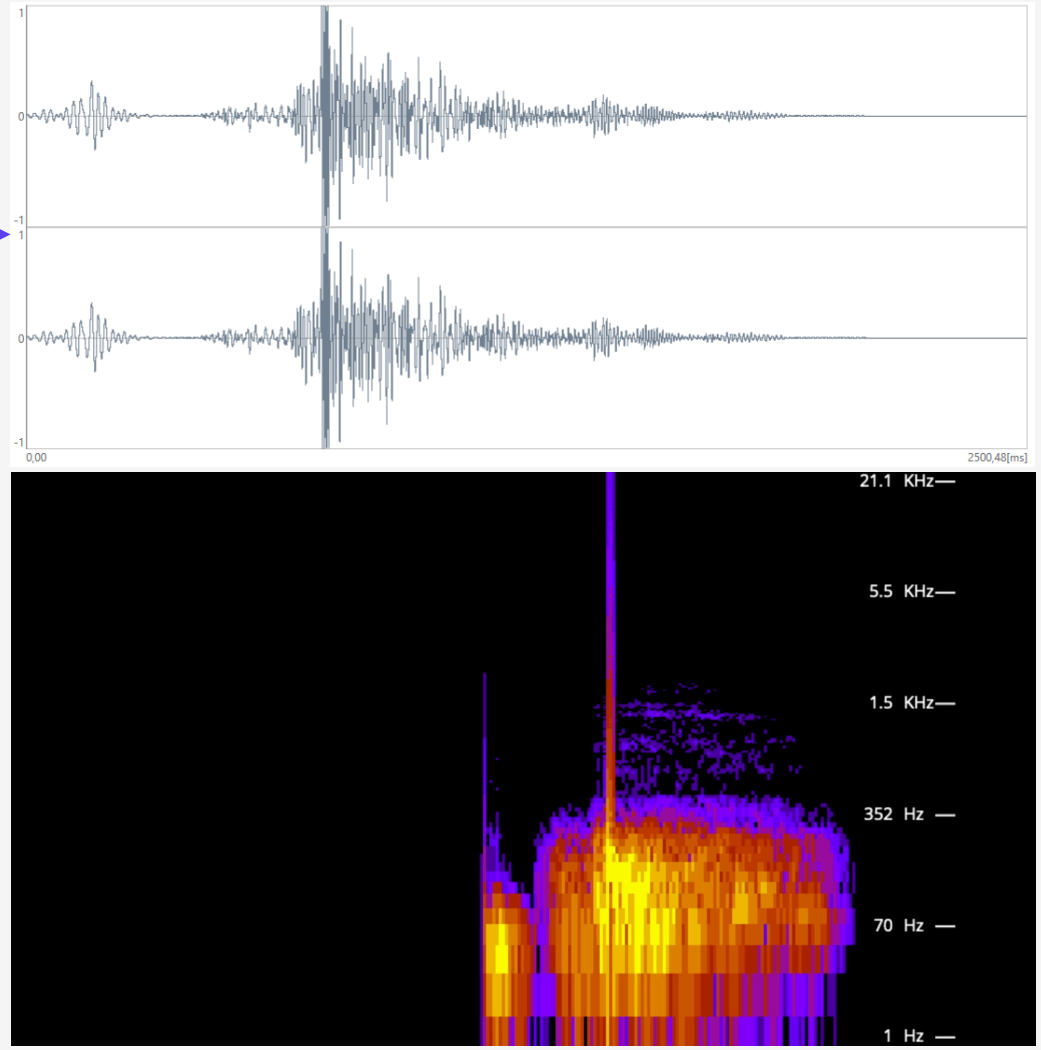
5. Add a Sine Pulse



80 Hz, 2 cycles, 1.0 amplitude

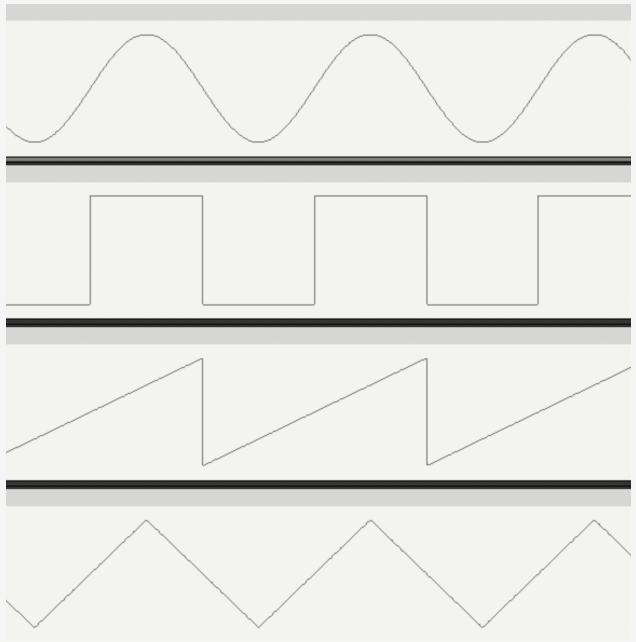
Result


0,00
2500,48[ms]
21.1 KHz
5.5 KHz
1.5 KHz
352 Hz
70 Hz
1 Hz


0,00
2500,48[ms]
21.1 KHz
5.5 KHz
1.5 KHz
352 Hz
70 Hz
1 Hz

Basic Synthesized Sounds

Tone
(sine / square / triangle / sawtooth wave)

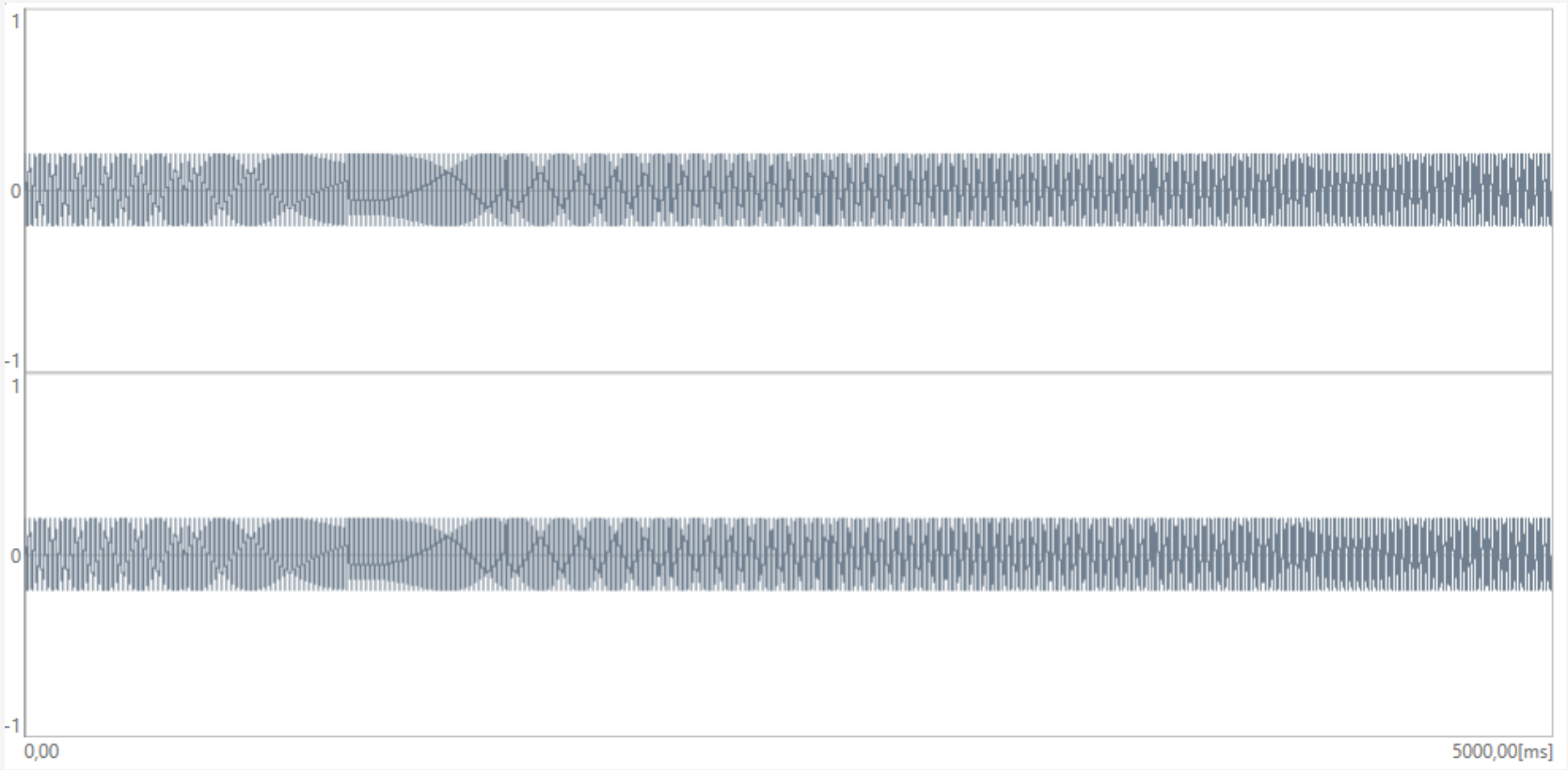


Chirp

Noise

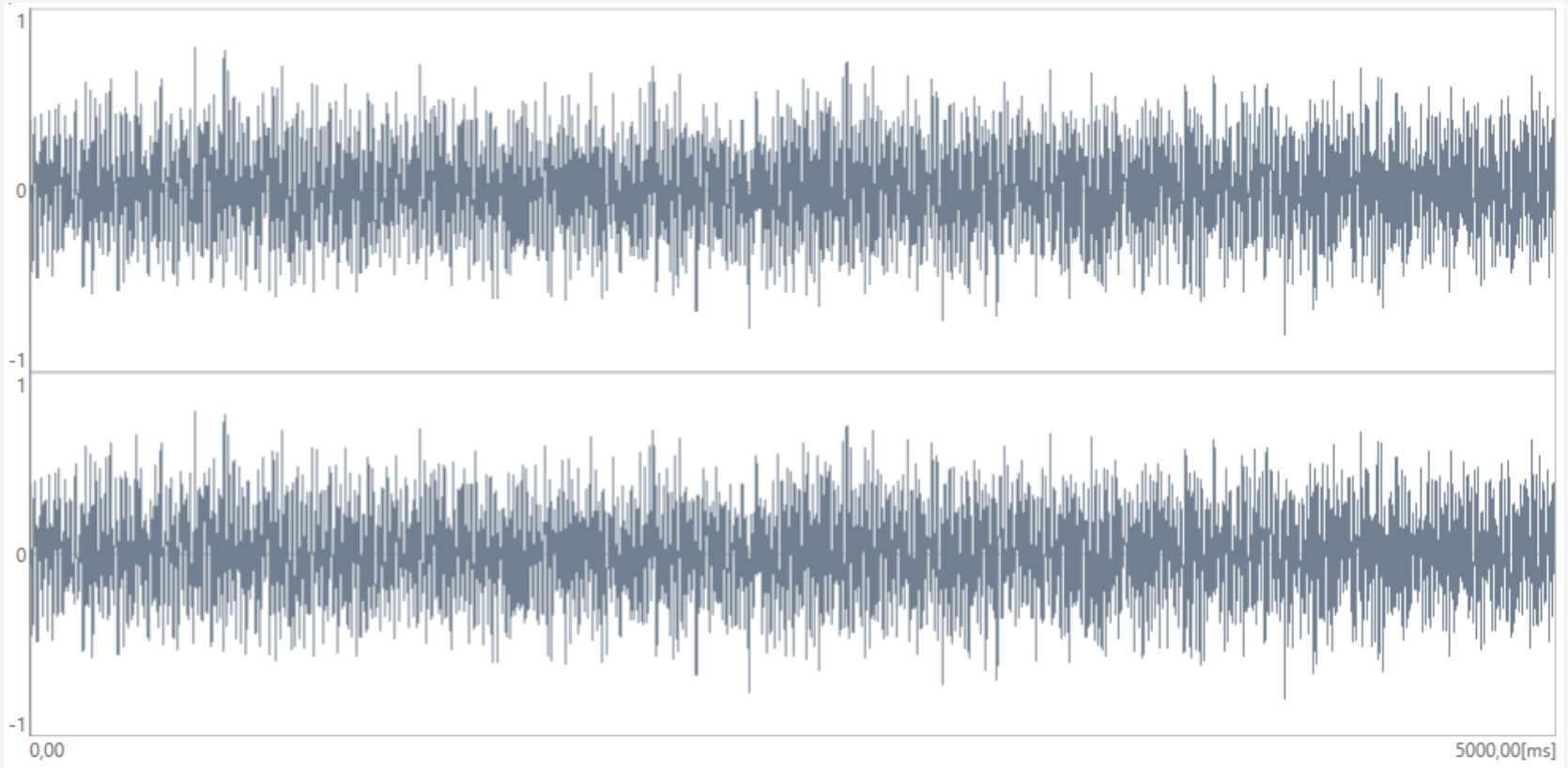
+ filters

1. Generate Foundation



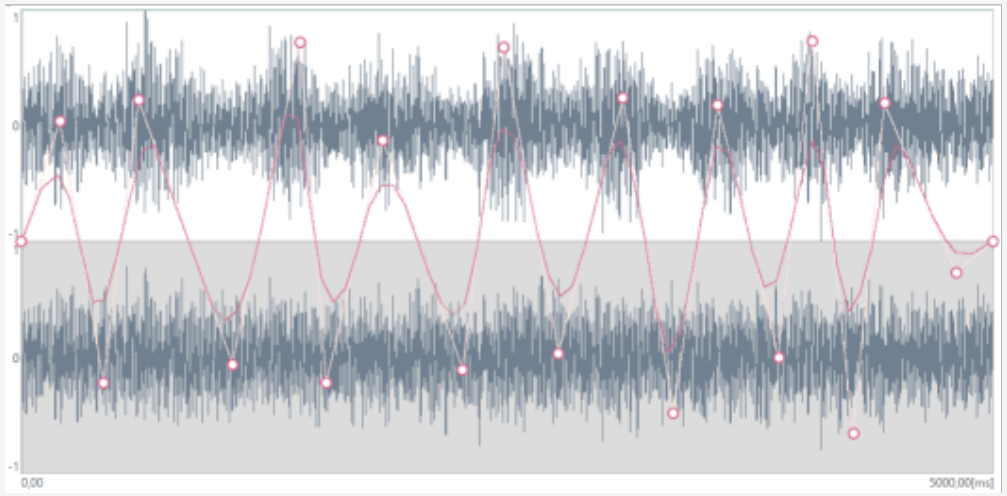
Chirp - 60-80 Hz - 0.2 amplitude

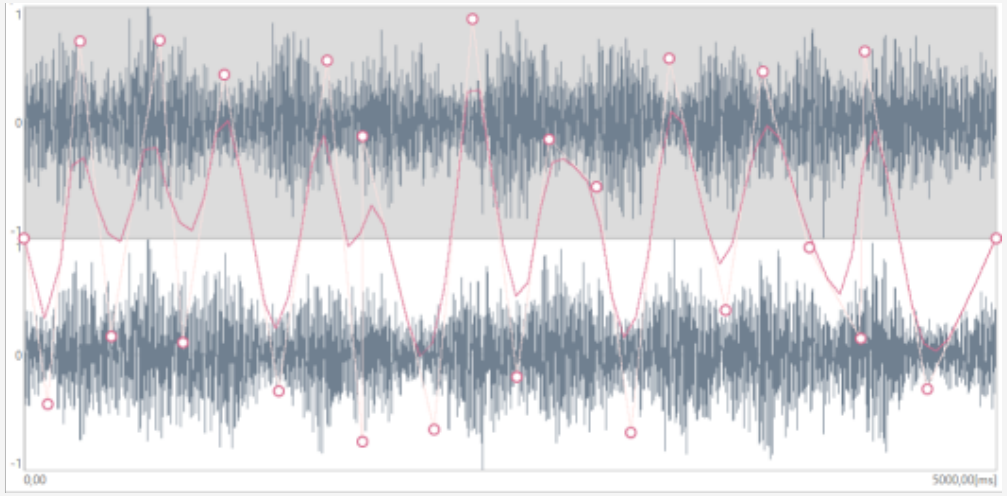
2. Add Noise



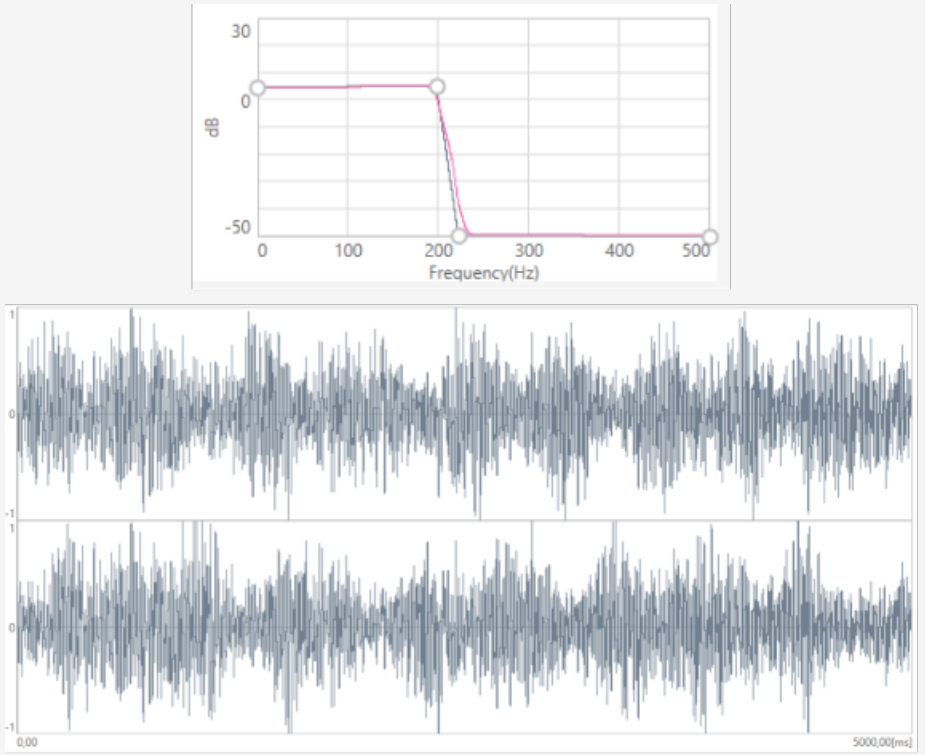
0.65 amplitude

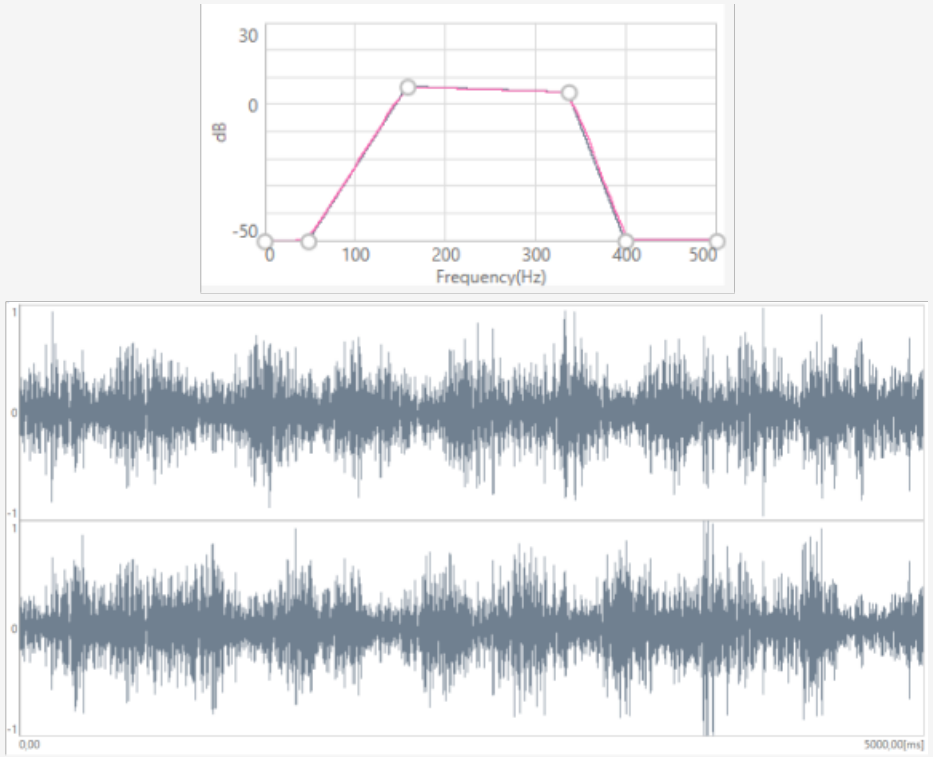
3. Add Per-Channel Envelope



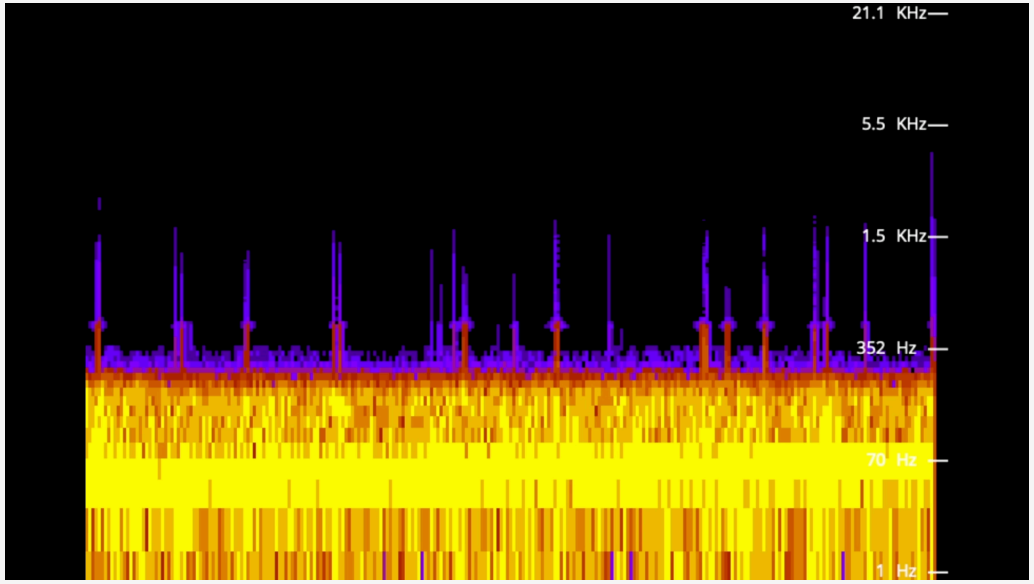


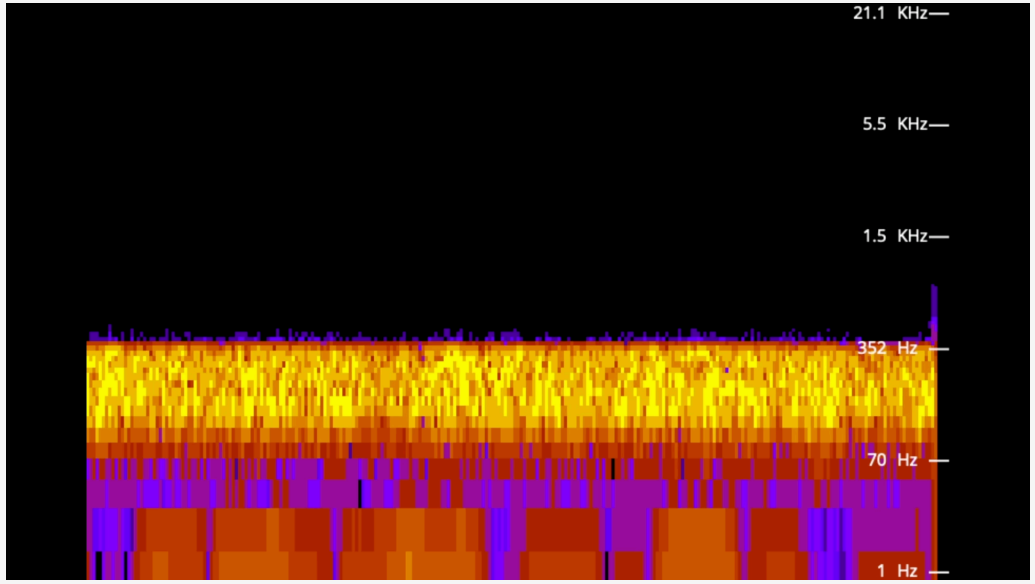
4. Add two layers of EQ



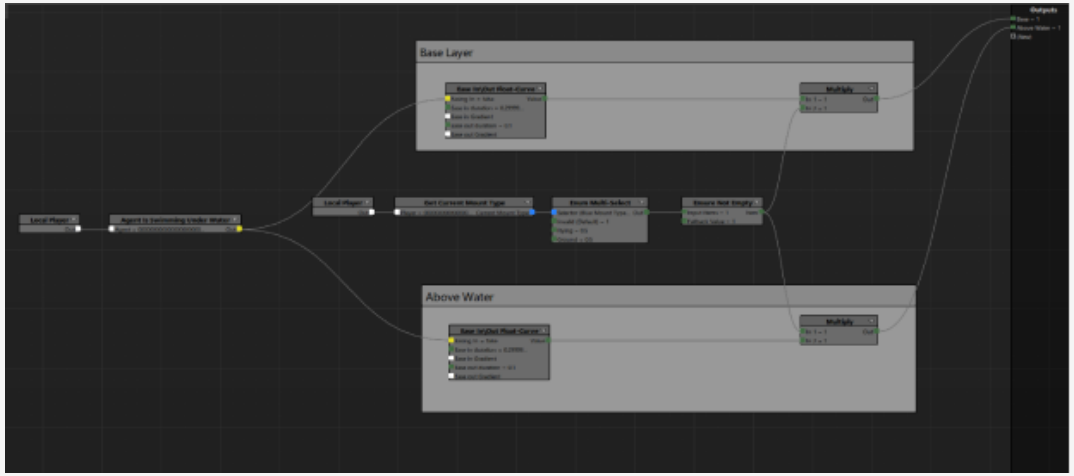


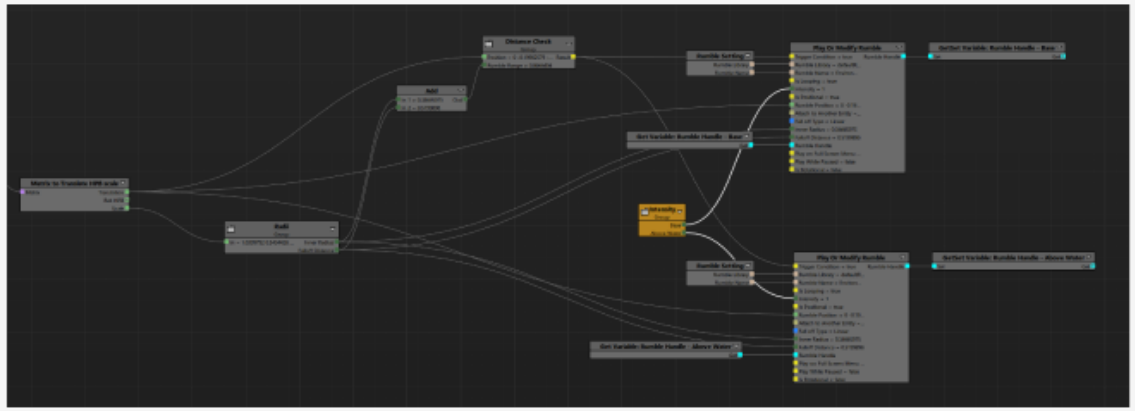
Pre-Processing Result





5. Pre-Mix Layers Using Node Graph Logic





+ Positional and orientational processing in code

Tools

Sony Vibration Designer

Adobe Audition

Audacity

Music-Focused DAWs

Closing Thoughts
AVATAR
FRONTIERS OF PANDORA
™ & © 20th Century Studios. Game Software © Ubisoft Entertainment

How Did It Go?

+ Short iteration loop

+ A lot of content

+ Good prioritization

- Not enough pipelines

- Node graph optimization

Reception

DualSense Controller

The DualSense is an absolute treat with this game. It's almost as if this game was made specifically for PlayStation 5.

Adaptive triggers come into play more than any game I've played in recent times (aside from Spider-Man 2). I love to see it.

Snapping branches off trees requires precision pressure on the adaptive trigger and you'll need to force through that final resistance to snap it.

Using the SID tool utilises the triggers again, scanning for tech and wiring pathways. Finding a fault sees you use just enough pressure on the right trigger to pinpoint frequencies.

And of course, when pulling back the drawstring on your bow and firing an arrow. You can feel it all.

Climbing rocks and cliffs is felt through the haptic vibrations in the controller, as is jumping and landing. Even standing by a crackling fire can be felt through the haptics.

Follow

Best DualSense Support:

Avatar: Frontiers of Pandora

DualSense support for this is "launch PS5 era" crazy

They made the gathering so much more interesting taking full use of the haptic triggers and feedback.

Raindrops and fire and moving through environment was 🥰 even on PC

The dualsense haptic feedback is very well implemented (one of the best implementations I've seen) and really adds to the immersion.

14 Reply Share

after playing for a few hours, I'm hyped to jump back in. Really a phenomenal sounding and looking world! Using dualsense on pc really feels great too, the haptic feedback in this game might be the best I've ever seen utilized in a game.

Reply Share

Lastly, we have to mention the DualSense implementation because it is fantastic here. Whether you are peppering RDA mechs with an assault rifle or lining up a shot with your heavy bow, the details in the haptics and adaptive triggers are on the level of a Sony first-party title. It's really impressive.

The PlayStation 5's DualSense Adds a New Layer of Immersion to Avatar: Frontiers of Pandora

Of course, the PlayStation 5 isn't the only console that can deliver great visuals at a consistent framerate, nor is it the only console with an SSD built in, but it is the only console with DualSense integration. A love-it-or-hate-it feature, the PS5's DualSense is used incredibly well in *Avatar: Frontiers of Pandora*. While even some of the most prestigious AAA third-party titles can phone in their DualSense integration, *Avatar: Frontiers of Pandora* is not one of them, with the controller's adaptive triggers and haptic feedback working overtime in the world of Pandora.

Much like any other self-respecting first-person shooter on the PS5, the DualSense is used throughout *Avatar: Frontiers of Pandora* to deliver unique effects based on the type of weapon the player is firing. For instance, if the player is using a standard bow, then the left trigger will push back when the arrow is shot, imitating the push-back the player-character would feel in their left hand as the arrow hits off the side of the bow. Using a heavy bow will cause the adaptive triggers to push back even more. Using a human weapon like an RDA shotgun or assault rifle feels completely different from using a bow, with the haptic feedback in the DualSense going the extra mile to make the weapon feel suitably powerful.

But it's not just *Avatar: Frontiers of Pandora*'s weapons that make full use of the DualSense. *Avatar* uses the DualSense's hatpic feedback at all times during the game. Whether it's the player's footsteps in water, the beating of the Ikran's wings, the stomp of the Direhorse's hooves on the ground, or the crunch of leaves beneath the player's feet, every action in *Avatar: Frontiers of Pandora* can be felt with the DualSense, bringing a whole new layer of immersion to the game.

Follow

I cannot say enough AMAZING things about @AvatarFrontiers! It's a BREATHTAKING game, and the use of the PS5 controller haptics blows me away! I can't wait to play more!

6:50 AM · Dec 11, 2023 · **92** Views

Some games have integration with DualSense, but few make good use of it. Avatar falls into the latter category. In the beginning you are given a basic tutorial on how to safely remove fruit, supplies, etc. to preserve them. It comes with an indicator that shows the direction and how hard you should pull. After a while, that tutorial goes away, as does the indicator. The haptic triggers provide sensitivity that you can't get anywhere else, with actual tension you can feel as you tug on a piece of fruit. Similarly, drawing your bow provides commensurate tension in the trigger pulls. Firing a machine gun is a visceral experience, as the controller bucks and shakes with the strongest chunking thumps it can provide. It's incredibly immersive and I highly recommend you give it a shot if you have a DualSense available – it's clear Ubisoft put a great deal of work into this feature, and I'm glad to see it included on PC and not just locked to the PlayStation 5.

What was pleasantly surprising (among many other things) is that this game has excellent DualSense integration. There are also pleasant vibrations in mini-games, such as where it is safe to remove fruits in order to preserve them. It is equipped with an indicator that shows the direction and force to be pulled. After a while, this guide will disappear, as will the indicator. Tactile triggers provide sensitivity you can't get anywhere else. Likewise, the draw of the bow ensures that the trigger is pulled in proportionately. Firing a machine gun is a visceral experience, as the controller shakes and shakes under the heaviest impacts, and even when you're just running around exploring, every step feels good in your hands. It's incredibly satisfying and I highly recommend you give it a try if you have a DualSense.

Our review was carried out on PS5 with it's unique DualSense 5 controller features being used to their full capabilities. Stretching your arrow back in your bow and gathering wild fruit and other plant life results in varying levels of resistance from the adaptive triggers. The haptic feedback also delivers some impressively subtle yet impressive aspects to the game with rain showers and nearby fire sources adding tiny little vibrations to the controller along with its built in speaker being used for a number of gameplay and weapon mechanics also.

Takeaways

1. Define Your System

2. Think Holistically

3. Get to Know Your Hardware

Number of Channels

Platform Support

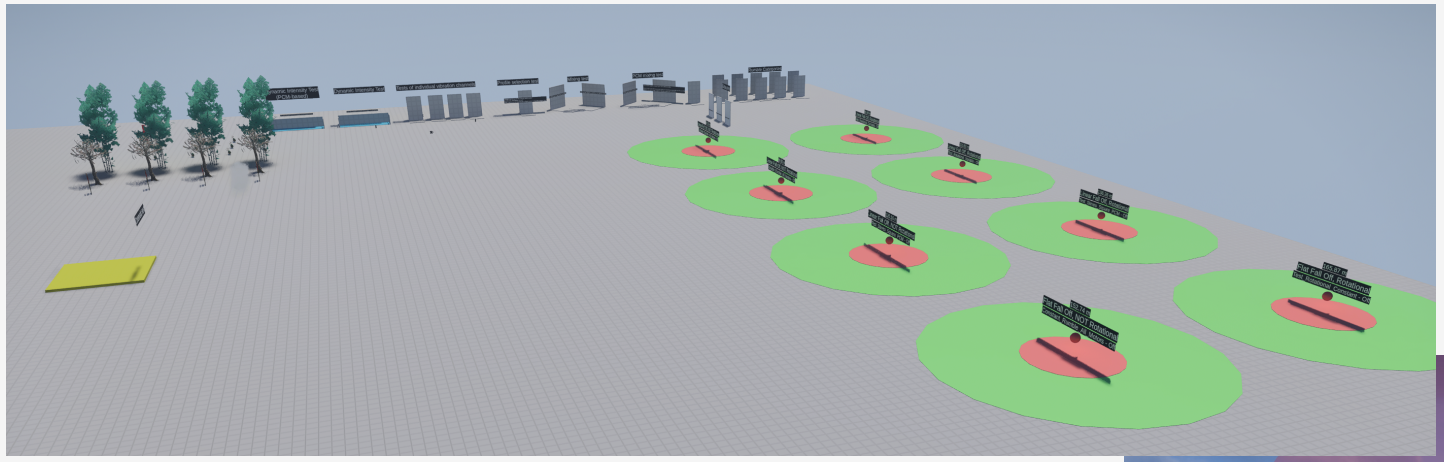
Warm-Up and Wind-Down Times

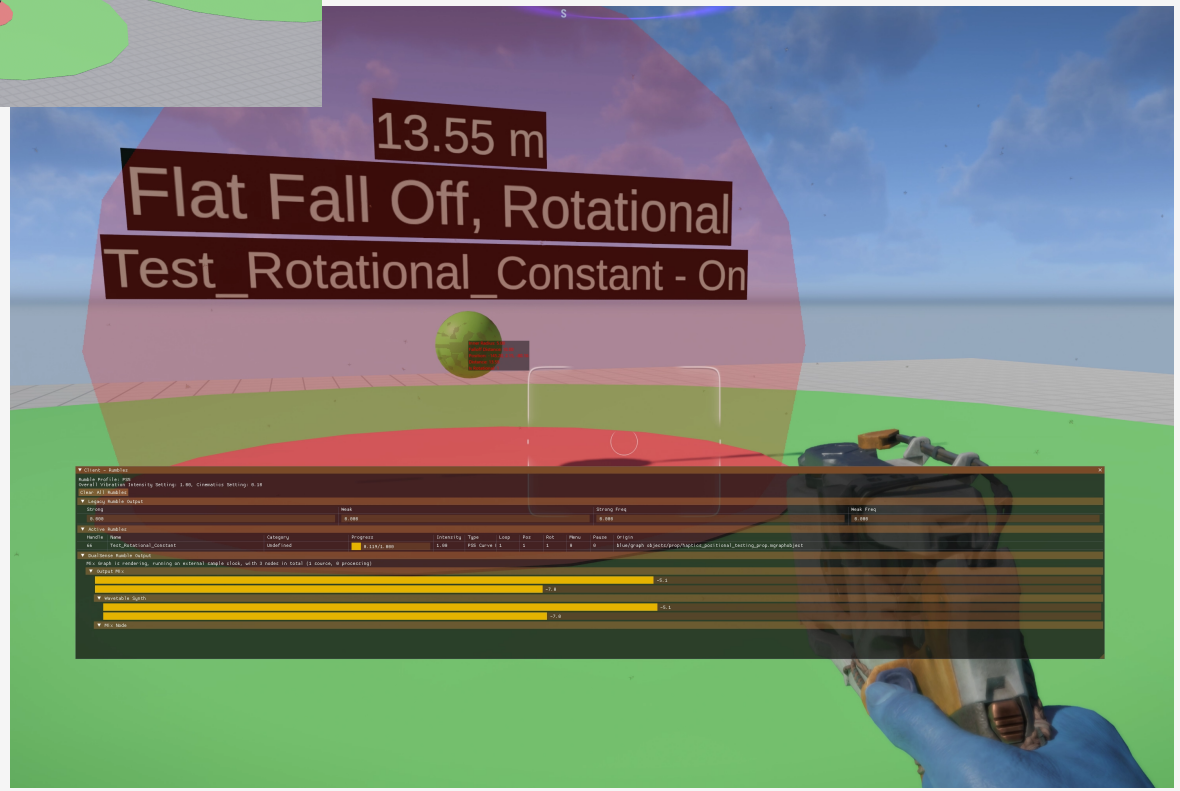
Usable Frequency Ranges

Latency

4. Don’t Underestimate the Xbox Gamepad

5. Invest in Debug Tools





6. Learn Basics of Audio

7. Create a Pipeline

(or book extra time to play catch-up)

8. Get the Team On Board

(including co-dev partners)

Thank you!

Data-Driven Haptic Feedback in Avatar: Frontiers of Pandora

1. **Define Your System**
2. **Think Holistically**
3. **Get to Know Your Hardware**
4. **Don’t Underestimate the Xbox Gamepad**
5. **Invest in Debug Tools**
6. **Learn Basics of Audio**
7. **Create a Pipeline**
8. **Get the Team On Board**

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Slides

mosiejczuk.pl/talks