INSIDE Audio

The Playdead Approach to Audio

ITU 2016
Jakob Schmid
PLAYDEAD

Me

Jakob Schmid

Audio programmer at PLAYDEAD

Composer and sound designer by night

Overview

- Introduction
- Audio Engine Overview
- Animation events
- Voice sequencer

Slides will be available online!

INSIDE

PLAYDEAD

Released soon for Xbox One

Commenced 2010

Playdead Audio Team

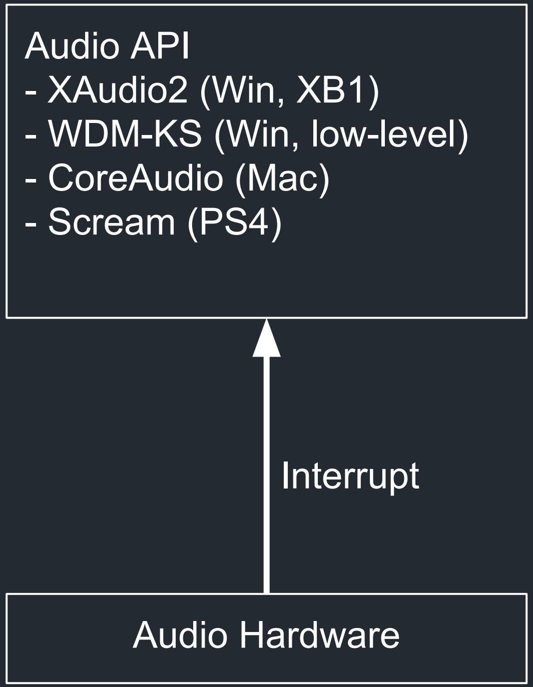
Martin Stig Andersen	audio director, sound designer, composer
Andreas Frostholm	sound designer
Søs Gunver Ryberg	composer, sound designer
Jakob Schmid	audio programmer

Audio Engine Overview

Audio Engine Overview

Audio Hardware

Audio Engine Overview

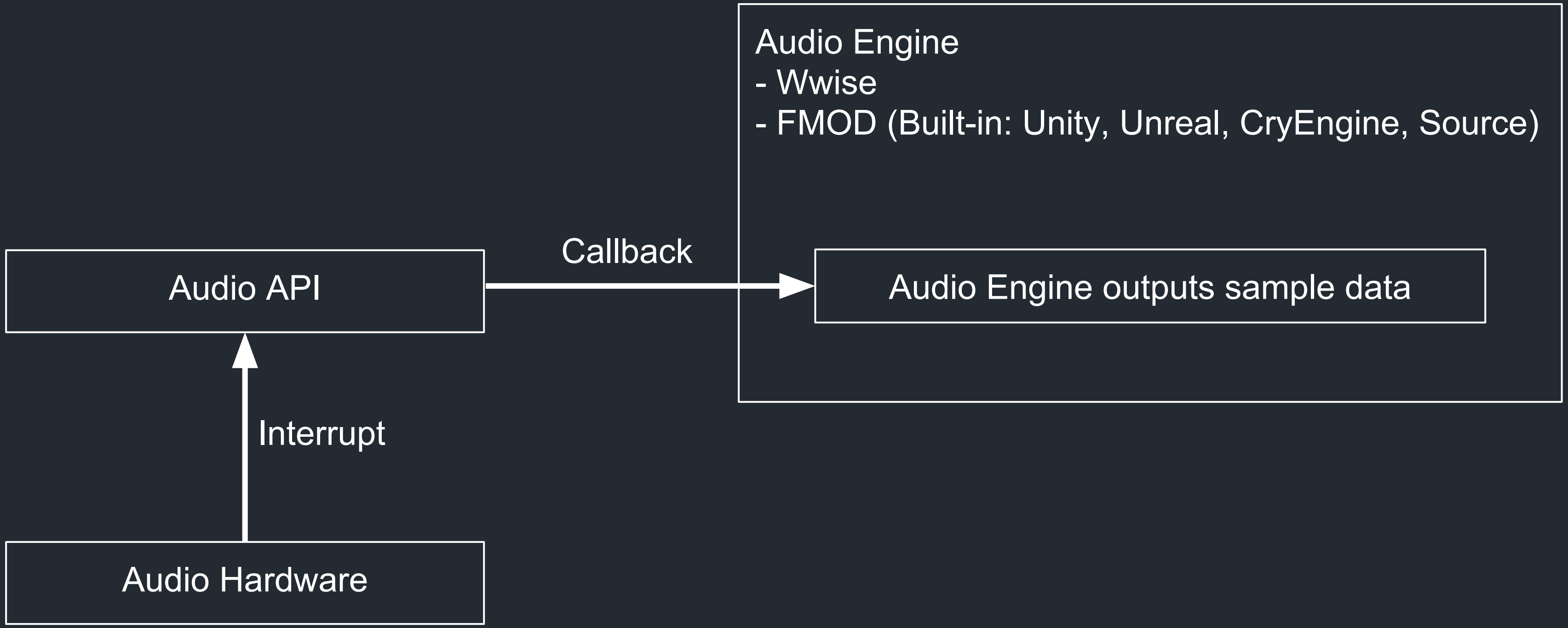


Audio API
- XAudio2 (Win, XB1)
- WDM-KS (Win, low-level)
- CoreAudio (Mac)
- Scream (PS4)

Interrupt

Audio Hardware

Audio Engine Overview



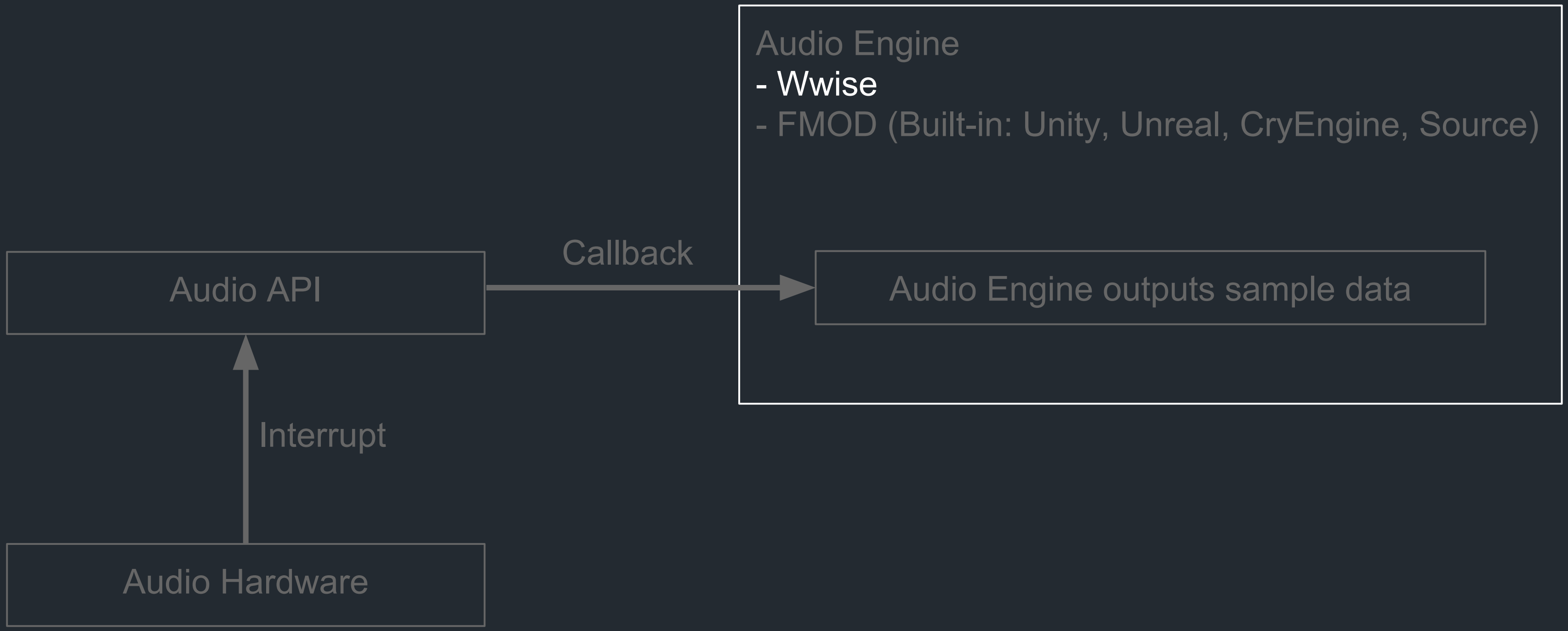
Audio Engine
- Wwise
- FMOD (Built-in: Unity, Unreal, CryEngine, Source)

Audio Engine outputs sample data

Audio API

Audio Hardware

Audio Engine Overview



Audio Engine
- Wwise
- FMOD (Built-in: Unity, Unreal, CryEngine, Source)

Audio Engine outputs sample data

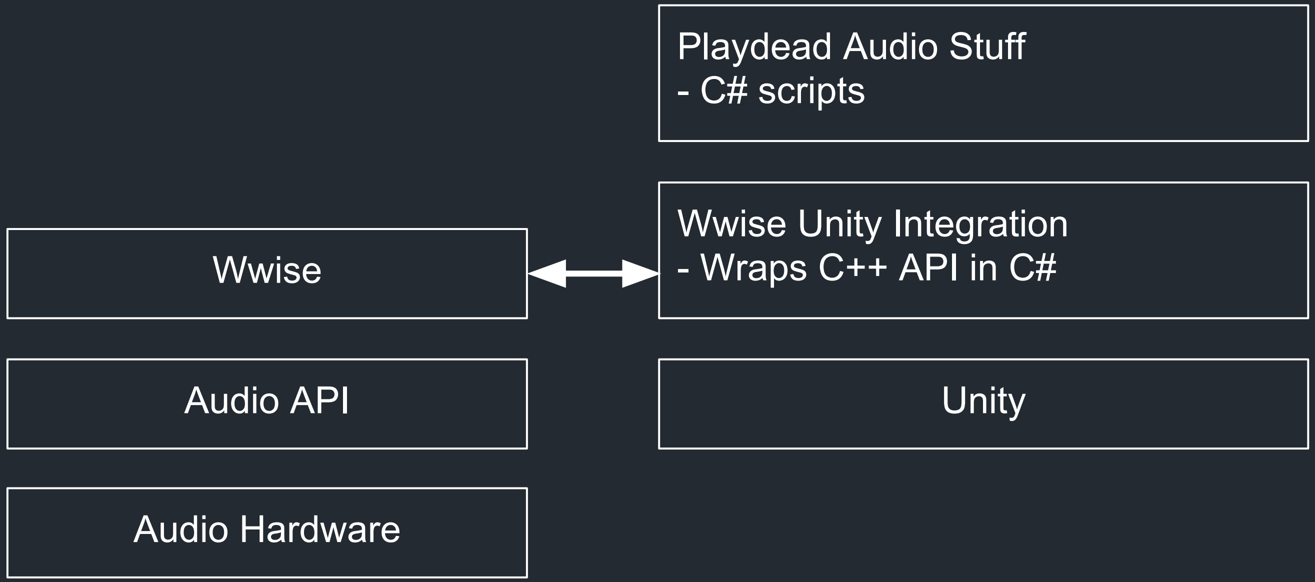
Callback

Audio API

Interrupt

Audio Hardware

Playdead Audio Engine Setup



Playdead Audio Stuff
- C# scripts

Wwise Unity Integration
- Wraps C++ API in C#

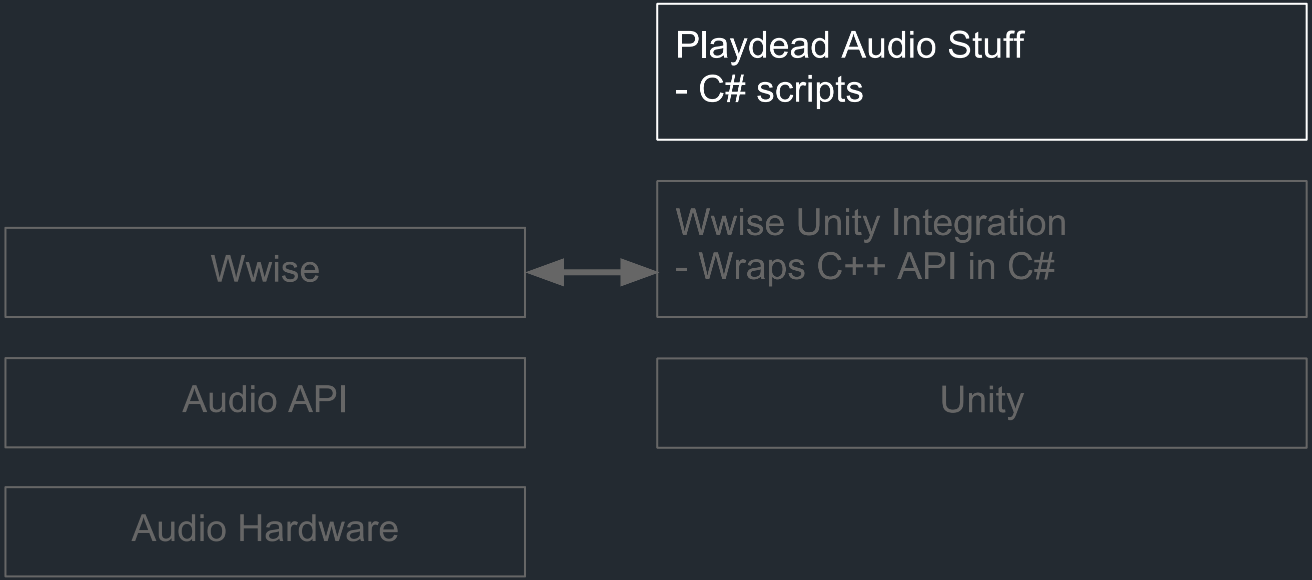
Wwise

Unity

Audio API

Audio Hardware

Playdead Audio Engine Setup



Playdead Audio Stuff
- C# scripts

Wwise Unity Integration
- Wraps C++ API in C#

Wwise

Audio API

Audio Hardware

Unity

Standard Unity Audio Code

Unity audio:

```
AudioSource audio;
AudioClip myClip;
audio.clip = myClip;
audio.Play();

// Modify sound while playing
// - here we use AnimationCurves
float t;
audio.pitch  = pitchCurve.Evaluate(t);
audio.volume = volCurve.Evaluate(t);
```

Wwise Unity Code

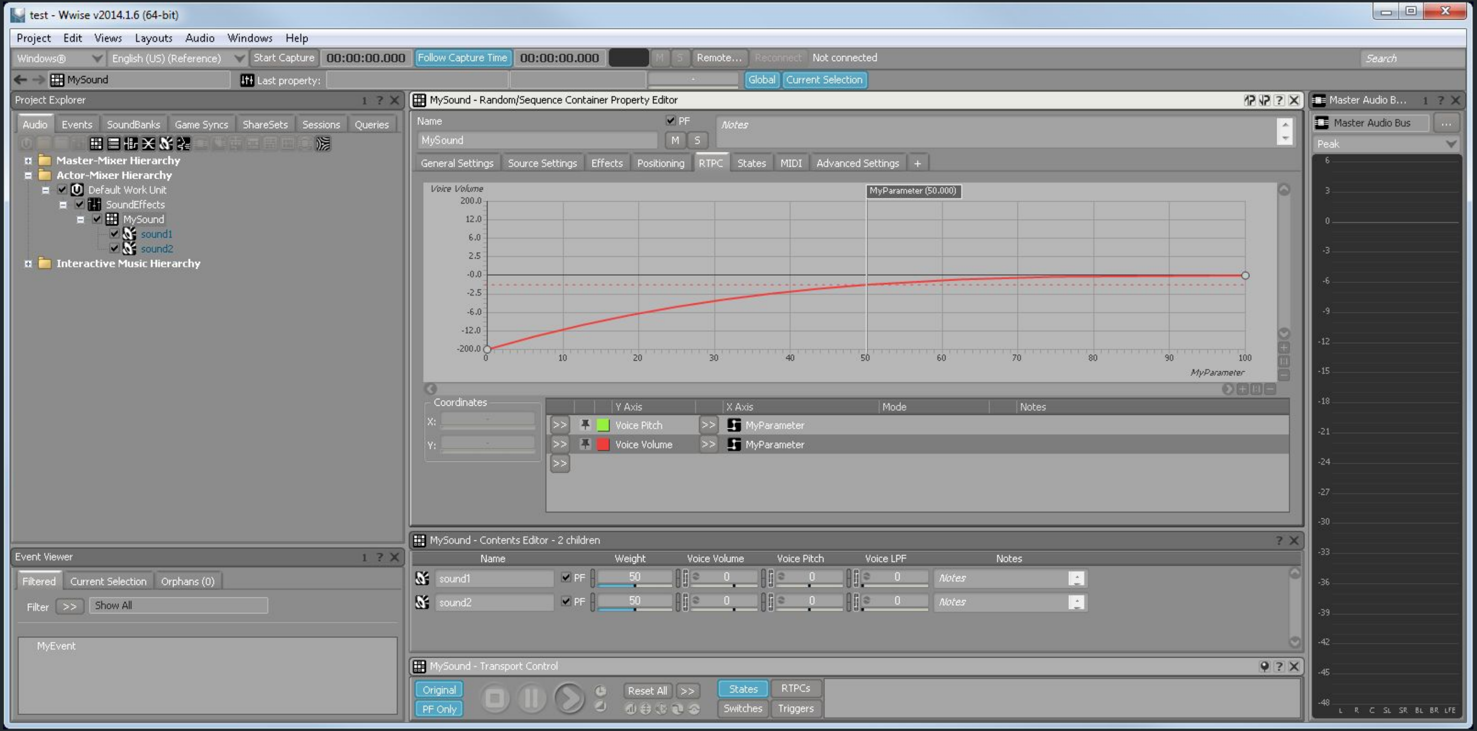
Unity audio:

```
AudioSource audio;
AudioClip myClip;
audio.clip = myClip;
audio.Play();

// Modify sound while playing
// - here we use AnimationCurves
float t;
audio.pitch  = pitchCurve.Evaluate(t);
audio.volume = volCurve.Evaluate(t);
```

Wwise Unity Integration:

```
GameObject go = this.gameObject;
AkSoundEngine.PostEvent("MySound", go);

// Modify sound while playing
// - modification is defined using external tool
float t;
AkSoundEngine.SetRTPCValue("MyParameter", t, go);
```

Wwise Workflow: Wwise Authoring Tool



Name: MySound ☑ PF M S

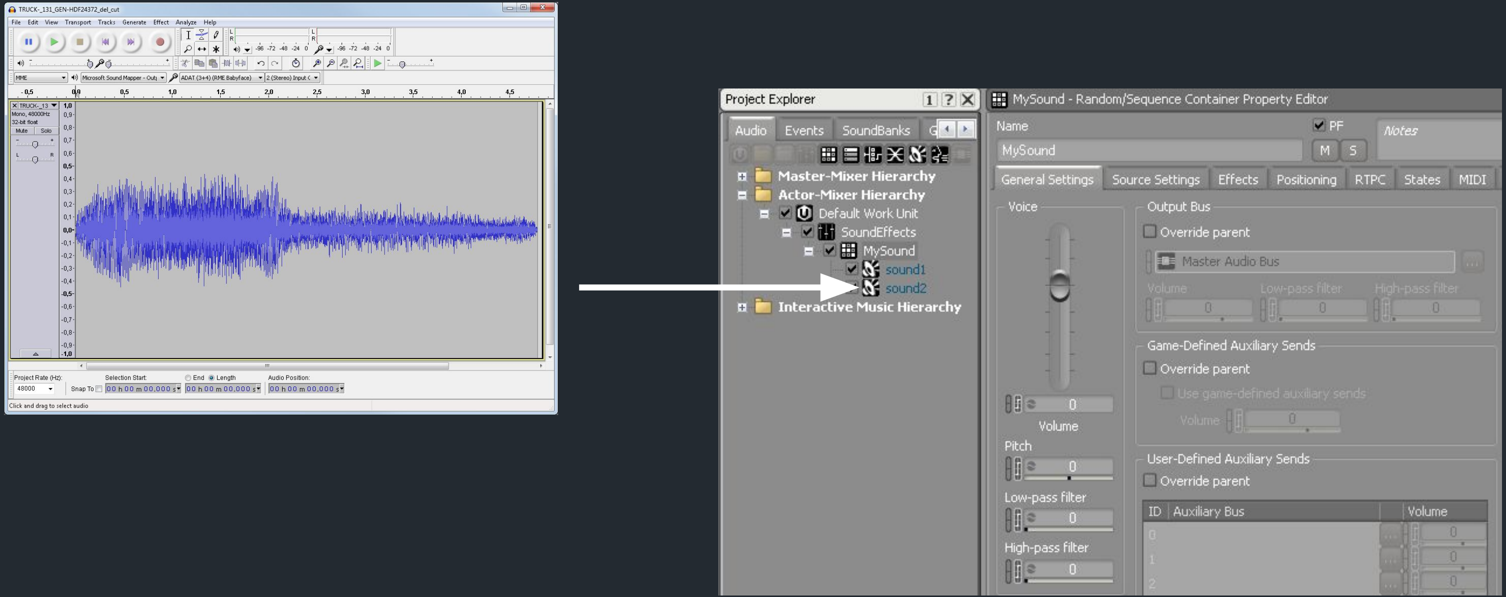
Notes

Y Axis	X Axis	Mode	Notes
🟩 Voice Pitch	MyParameter		
🟥 Voice Volume	MyParameter		

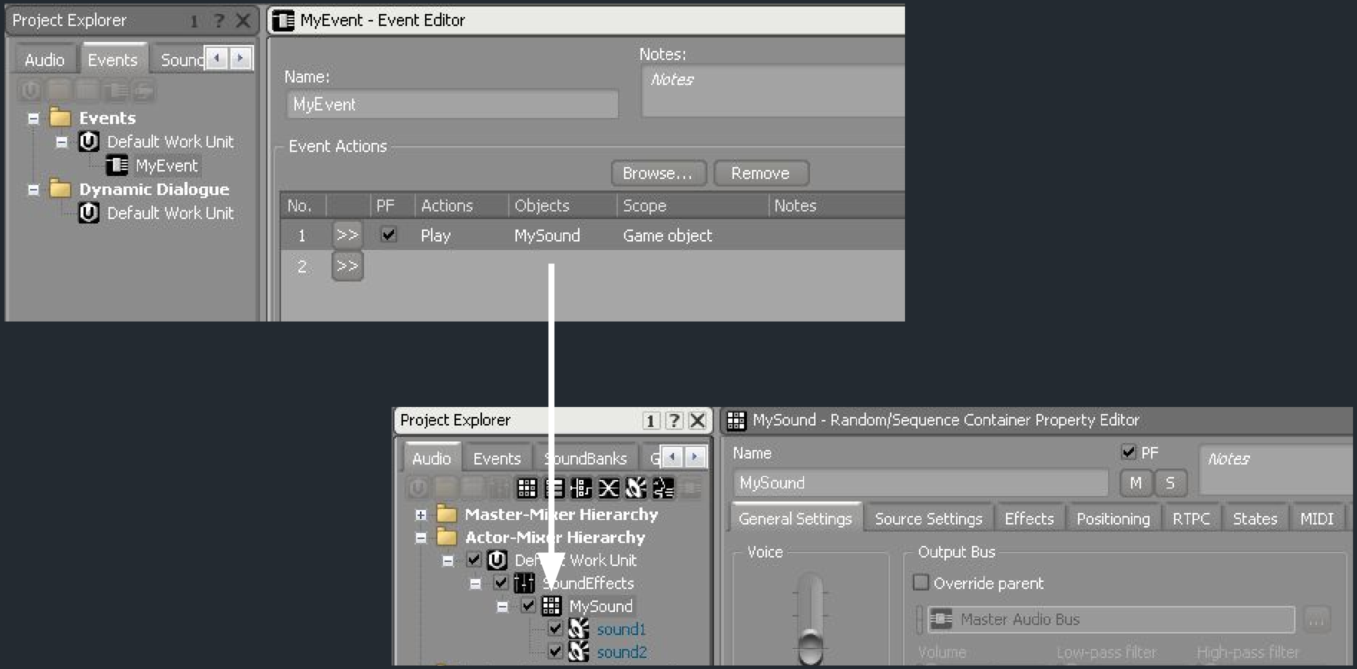
MySound - Contents Editor - 2 children

Name		Weight	Voice Volume	Voice Pitch	Voice LPF	Notes
sound1	☑ PF	50	0	0	0	Notes
sound2	☑ PF	50	0	0	0	Notes

Wwise Workflow: Defining Sounds



Wwise Workflow: Events



MyEvent - Event Editor

Name: MyEvent

Notes: *Notes*

Event Actions

No.		PF	Actions	Objects	Scope	Notes
1	>>	☑	Play	MySound	Game object	
2	>>					

MySound - Random/Sequence Container Property Editor

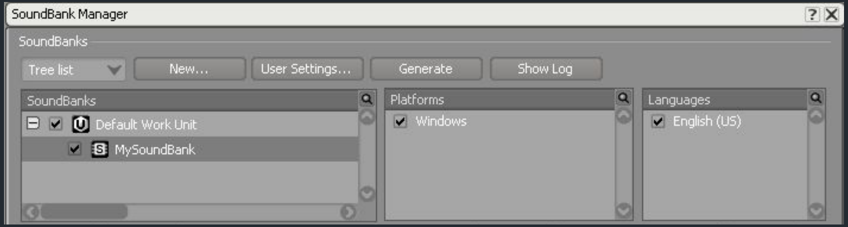
Name: MySound

☑ PF

Output Bus: □ Override parent

Master Audio Bus

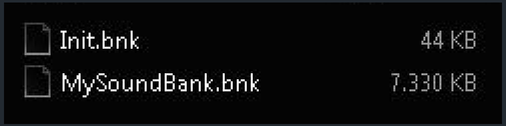
Wwise Workflow: Output Sound Banks



☑ Default Work Unit
☑ MySoundBank

☑ Windows

☑ English (US)

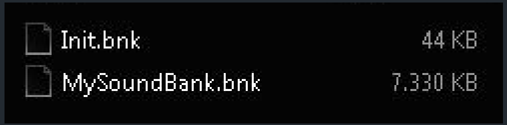


```
Init.bnk            44 KB
MySoundBank.bnk  7.330 KB
```

- Sound Banks contain a list of events
- ... And all the sounds used by the events

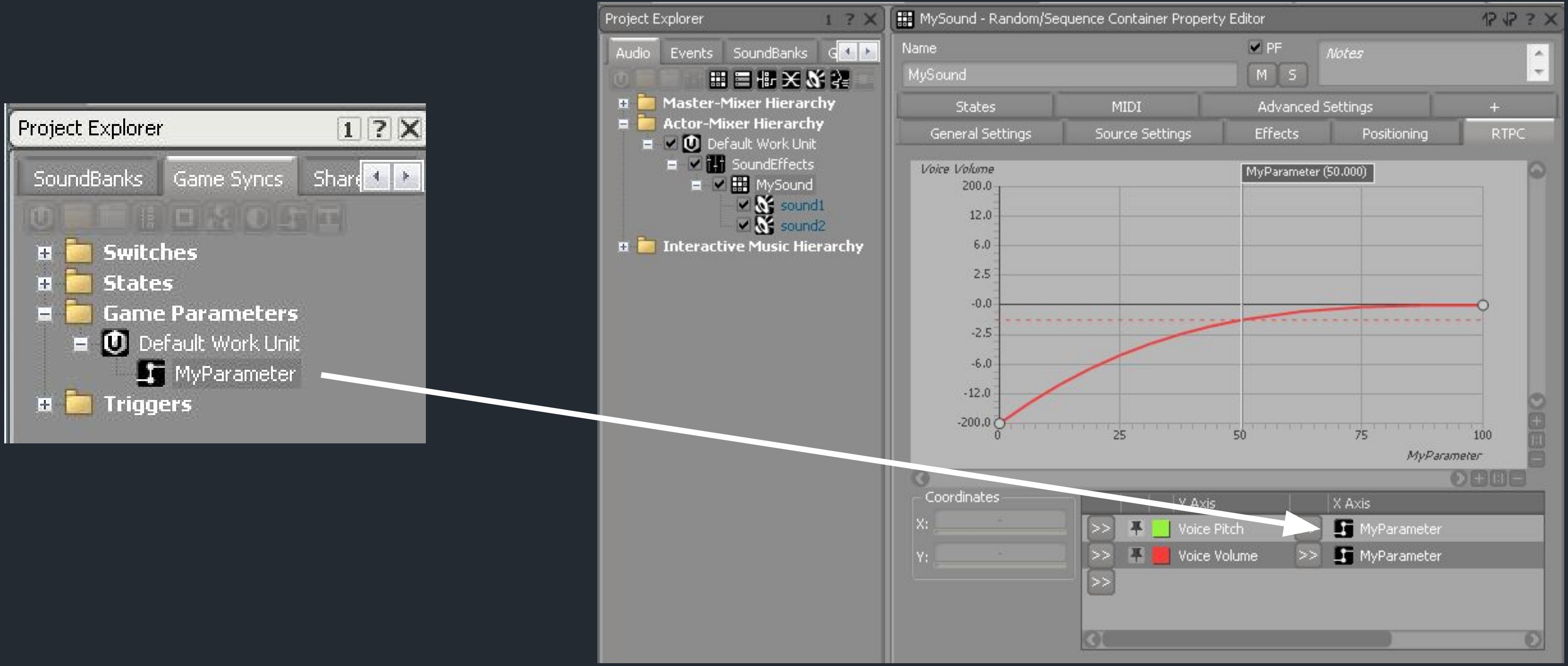
Wwise Workflow: Scripting

```
AkSoundEngine.LoadBank("Init.bnk", ... );
AkSoundEngine.LoadBank("MySoundBank.bnk", ... );

AkSoundEngine.PostEvent("MySound", go);
```



```
Init.bnk            44 KB
MySoundBank.bnk  7,330 KB
```

Wwise: Modify Playing Sounds

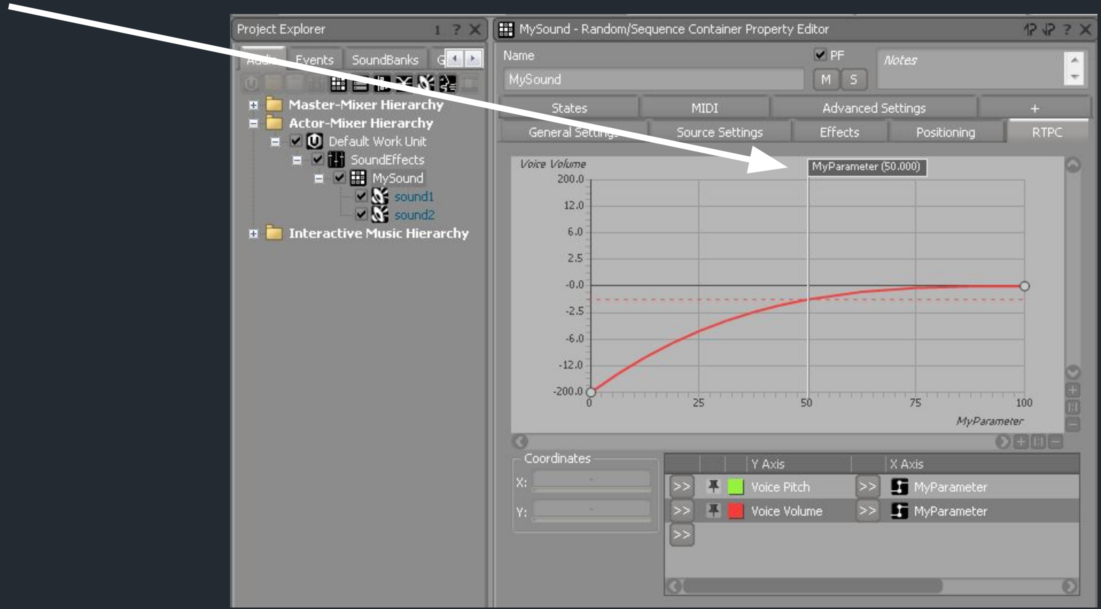


Name: MySound

			Y Axis		X Axis
>>		🟩	Voice Pitch	>>	MyParameter
>>		🟥	Voice Volume	>>	MyParameter
>>					

Wwise Workflow: Scripting

```
AkSoundEngine.PostEvent("MySound", go);
float t;
AkSoundEngine.SetRTPCValue("MyParameter", t, go);
```

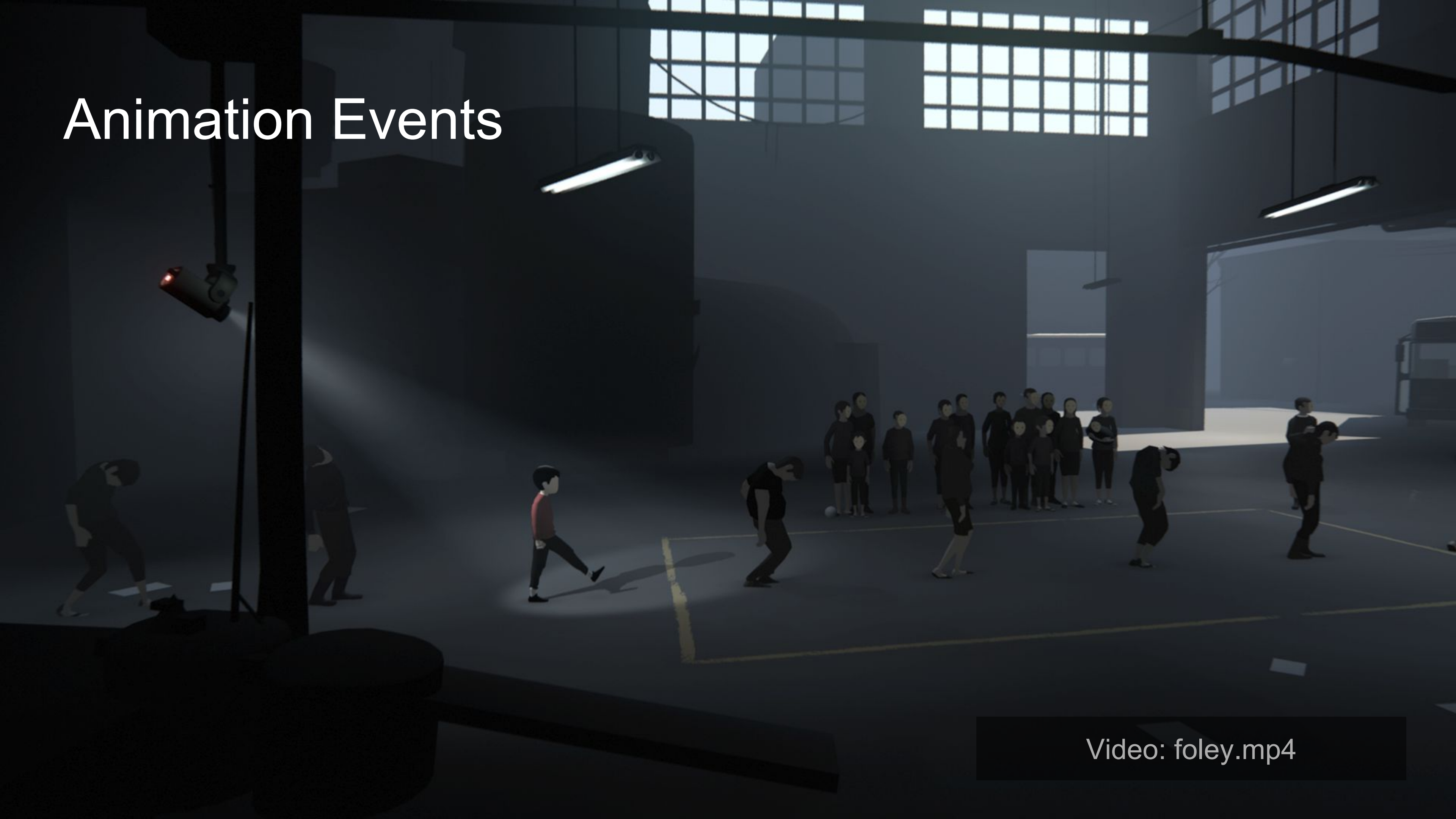


	Y Axis	X Axis
>>	🟩 Voice Pitch	>> MyParameter
>>	🟥 Voice Volume	>> MyParameter
>>		

Audio Engine Summary

- Common audio engines: FMOD (Unity built-in), Wwise
- Wwise Unity Integration, C#
- Sound designer works in Wwise Authoring Tool
- Sounds, parameter curves are set up in Wwise Authoring Tool (not engine)
- Has lots of functionality, simplifies audio implementation

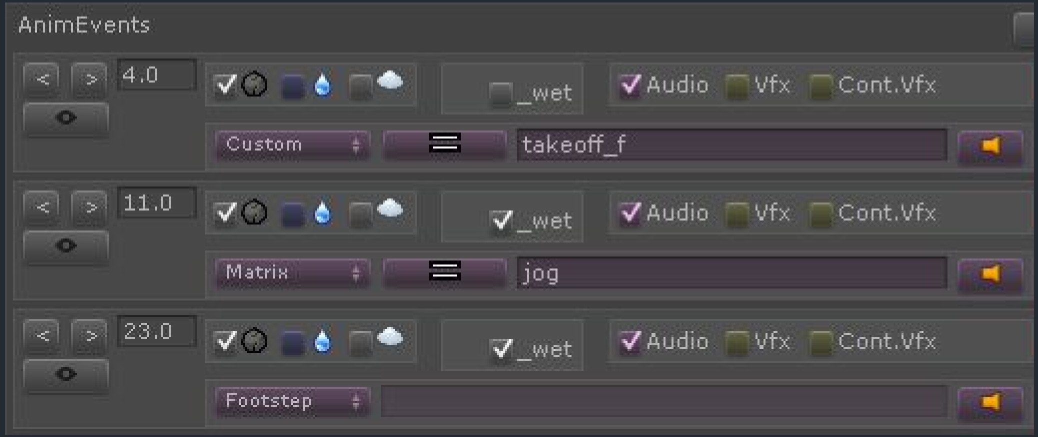
Animation Events



Video: foley.mp4

Animation Events

- Set up per animation
- Animation event types:
  - Custom
  - Matrix
  - Footstep (also matrix evts)
- Also used for VFX



AnimEvents

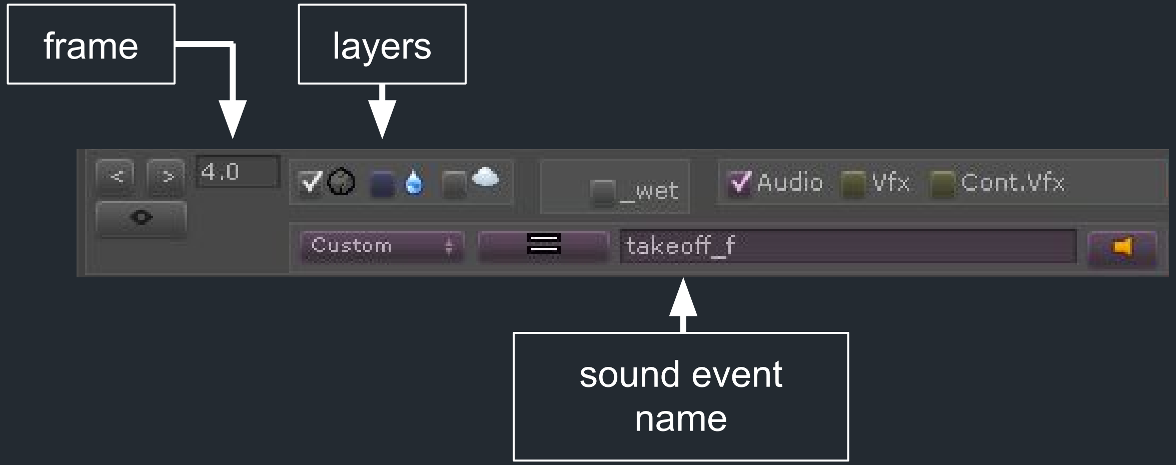
4.0 ☐ _wet ☑ Audio ☐ Vfx ☐ Cont.Vfx
Custom takeoff_f

11.0 ☑ _wet ☑ Audio ☐ Vfx ☐ Cont.Vfx
Matrix jog

23.0 ☑ _wet ☑ Audio ☐ Vfx ☐ Cont.Vfx
Footstep

Custom Animation Events

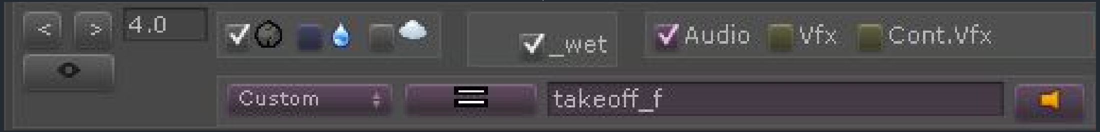
- Name of sound event specified directly
- Fires when animation frame has been passed
- Checks layers: ground, water, air



Wet Animation Events

- Optionally plays additional wet sound event
- Current wetness is sent as a parameter
  - Is set high when in water or on a wet surface
  - When dry, approaches 0 over time

add wet event



4.0

☑ _wet

☑ Audio □ Vfx □ Cont.Vfx

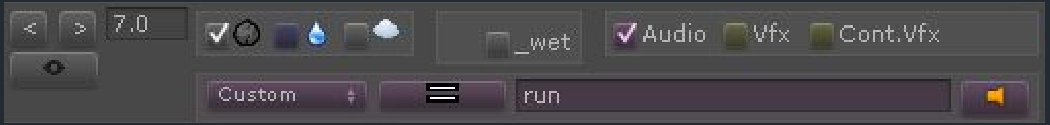
Custom

takeoff_f

Matrix Animation Events

- Matrix key instead of sound event name
- Context-dependent sounds

  e.g. from 'run' to 'stop' yields 'brake'



7.0

□ _wet

☑ Audio □ Vfx □ Cont.Vfx

Custom

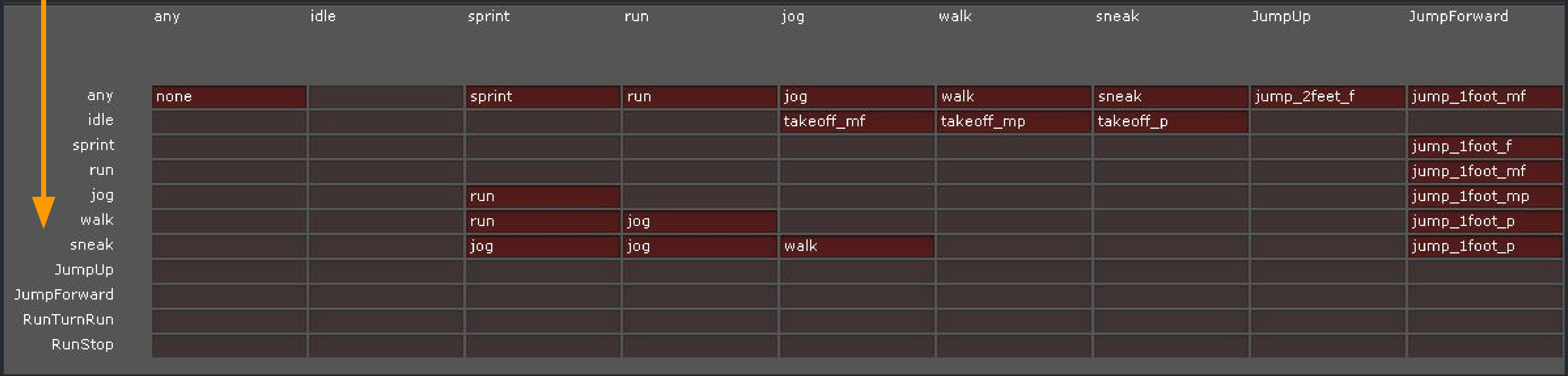
run

matrix key

Matrix Animation Events

previous key

current key



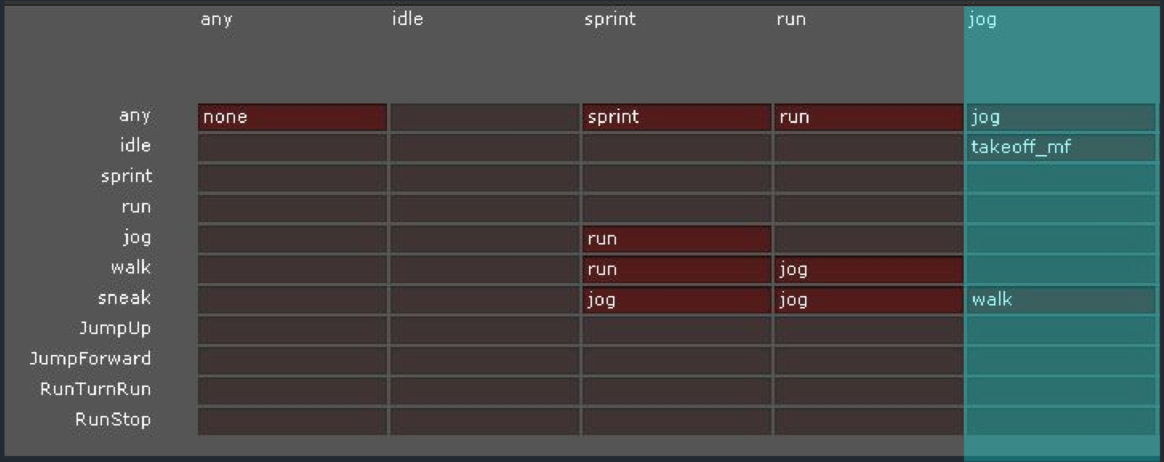
	any	idle	sprint	run	jog	walk	sneak	JumpUp	JumpForward
any	none		sprint	run	jog	walk	sneak	jump_2feet_f	jump_1foot_mf
idle					takeoff_mf	takeoff_mp	takeoff_p		
sprint									jump_1foot_f
run									jump_1foot_mf
jog			run						jump_1foot_mp
walk			run	jog					jump_1foot_p
sneak			jog	jog	walk				jump_1foot_p
JumpUp									
JumpForward									
RunTurnRun									
RunStop									

Current Matrix Key

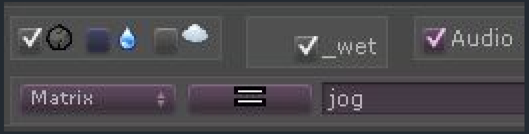
- Current key is specified in current animation event

jog

current key: jog



	any	idle	sprint	run	jog
any	none		sprint	run	jog
idle					takeoff_mf
sprint					
run					
jog			run		
walk			run	jog	
sneak			jog	jog	walk
JumpUp					
JumpForward					
RunTurnRun					
RunStop					



☑ _wet

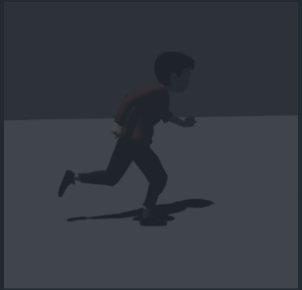
☑ Audio

Matrix = jog

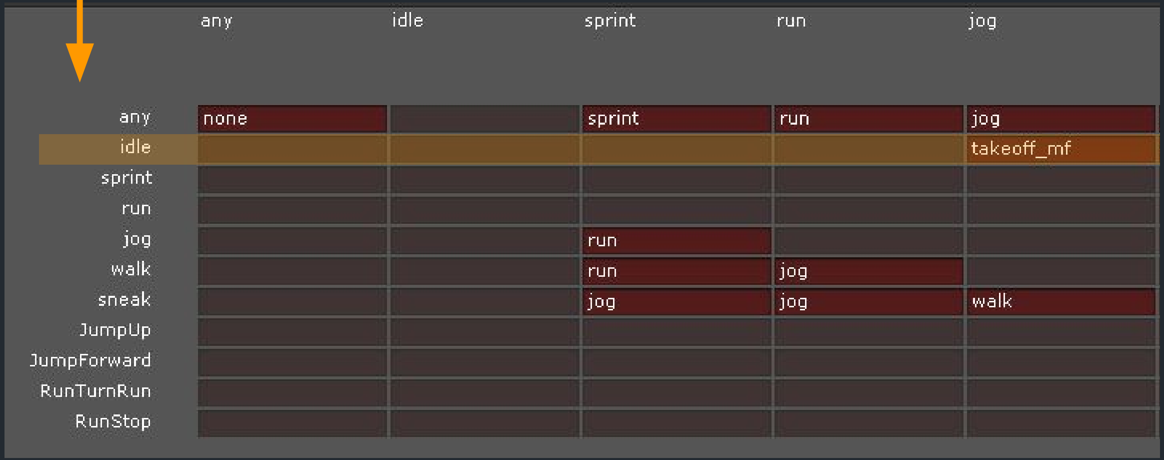
Previous Matrix Key

- Previous key was specified in previous animation event

idle



previous key: idle



	any	idle	sprint	run	jog
any	none		sprint	run	jog
idle					takeoff_mf
sprint					
run					
jog			run		
walk			run	jog	
sneak			jog	jog	walk
JumpUp					
JumpForward					
RunTurnRun					
RunStop					

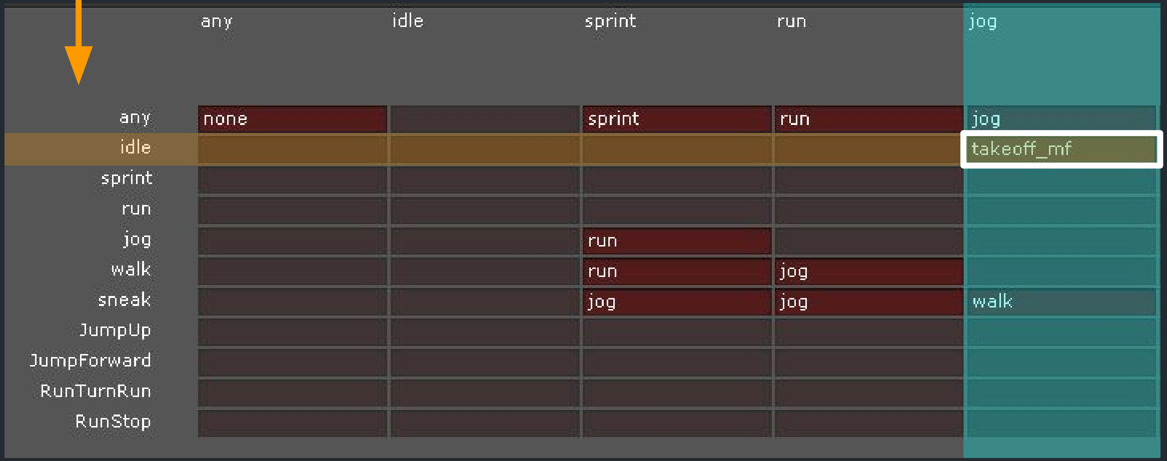
Play Sound

idle

jog

previous key: idle

current key: jog



	any	idle	sprint	run	jog
any	none		sprint	run	jog
idle					takeoff_mf
sprint					
run					
jog			run		
walk			run	jog	
sneak			jog	jog	walk
JumpUp					
JumpForward					
RunTurnRun					
RunStop					

play sound 'takeoff_mf'

Context Sensitivity

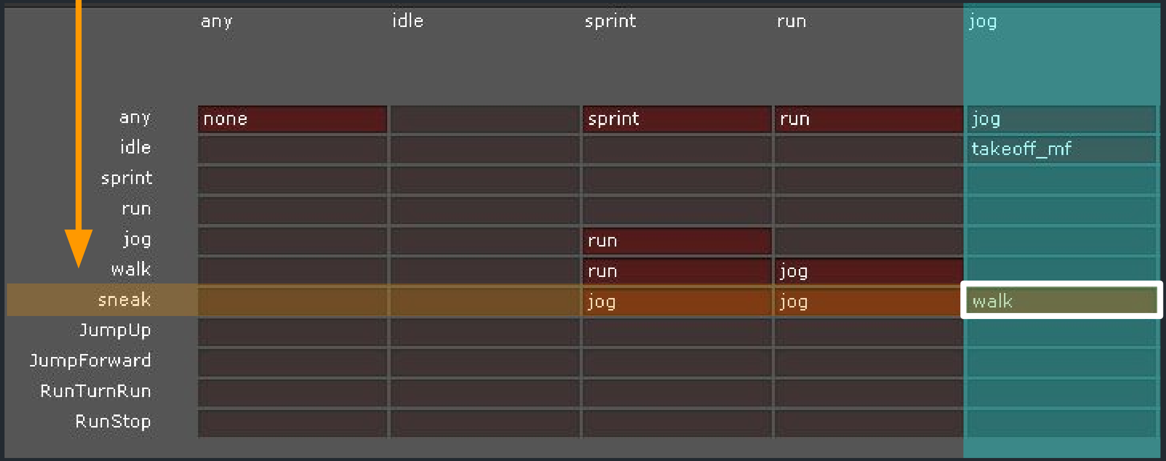
- If previous matrix key was 'sneak', a different sound is played

sneak

jog

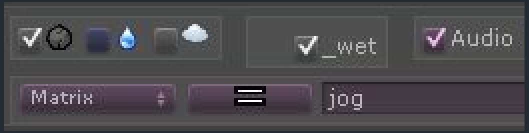
previous key: sneak

current key: jog



	any	idle	sprint	run	jog
any	none		sprint	run	jog
idle					takeoff_mf
sprint					
run					
jog			run		
walk			run	jog	
sneak			jog	jog	walk
JumpUp					
JumpForward					
RunTurnRun					
RunStop					

play sound 'walk'



☑ _wet ☑ Audio

Matrix = jog

Animation Events

Video: foley.mp4

Animation Events

Video: foley.mp4

Animation Events Summary

- Animation events occur at a specific frame
- Animation events are filtered based on layers
- Custom events specify sounds directly
- Matrix events are used for context-sensitivity

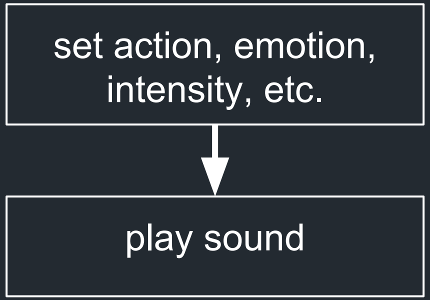
Voice Sequencer

Video: voice.mp4

Voice Sound Events

- Played by voice sequencer
- Which sound to play is defined by switches:
    - Action
    - Emotion
    - Intensity
    - etc.
- Intensity is a numeric value:
    - increases with physical exertion
    - decreases when idle

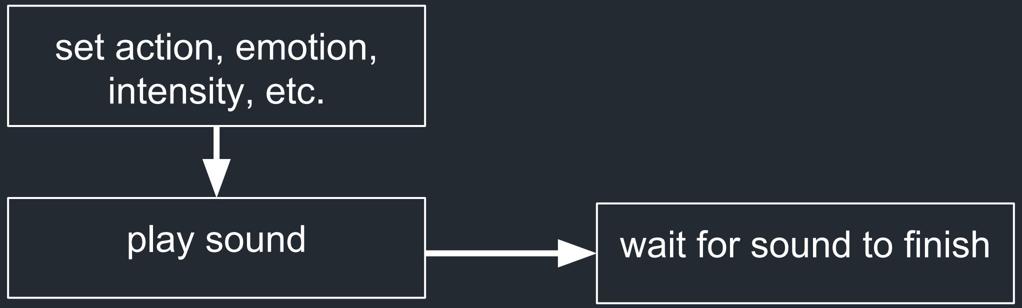
Voice Sequencer: Continuous Mode



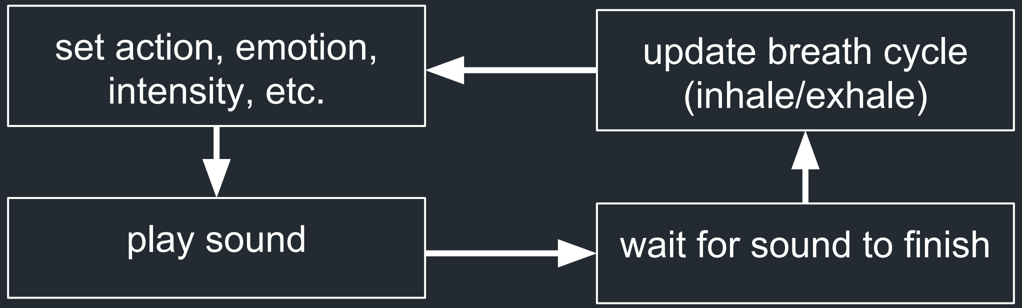
set action, emotion, intensity, etc.

play sound

Voice Sequencer: Continuous Mode

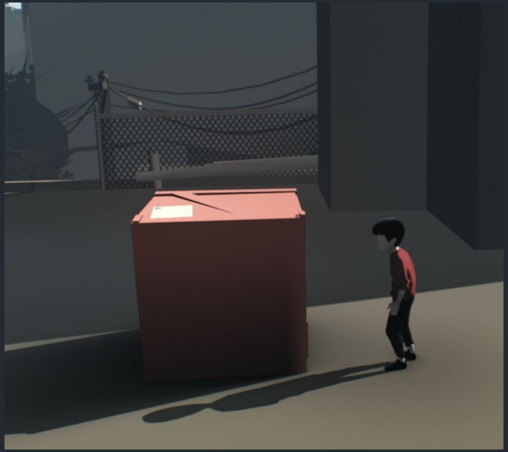


Voice Sequencer: Continuous Mode

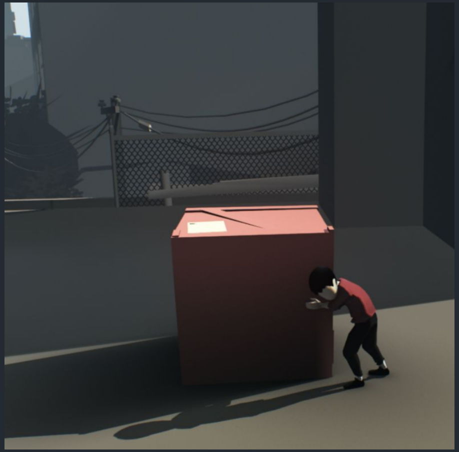

set action, emotion, intensity, etc.
play sound
wait for sound to finish
update breath cycle (inhale/exhale)

Engagement Actions

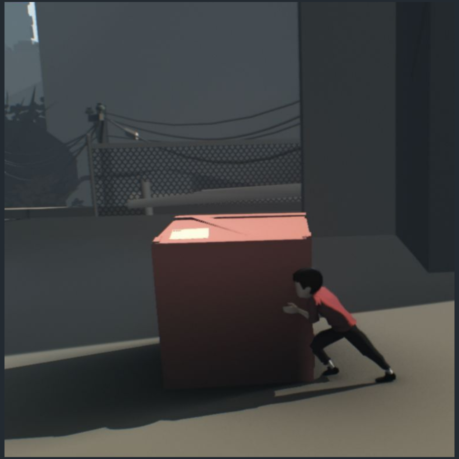
Special actions indicate performing work, uses different set of sounds



not engaged



engaged passive

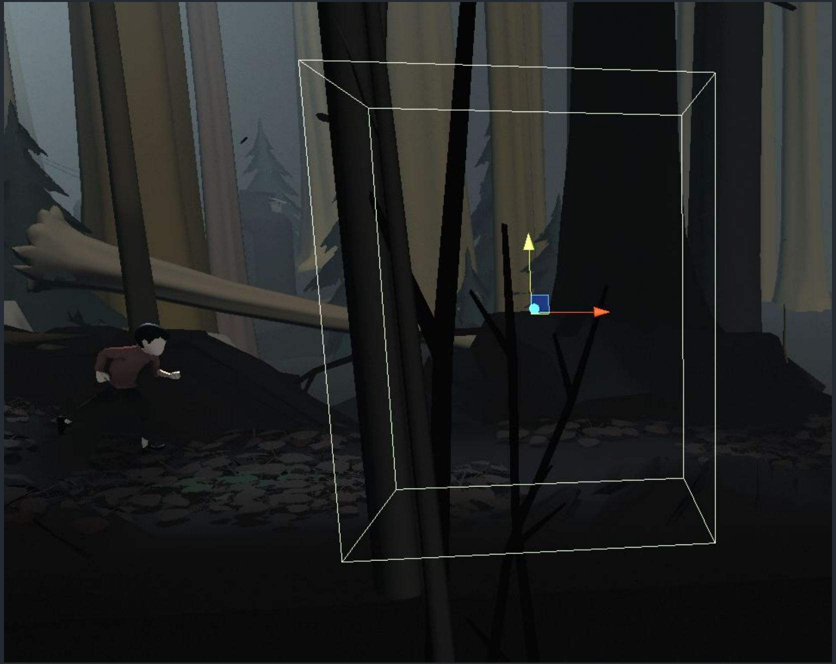


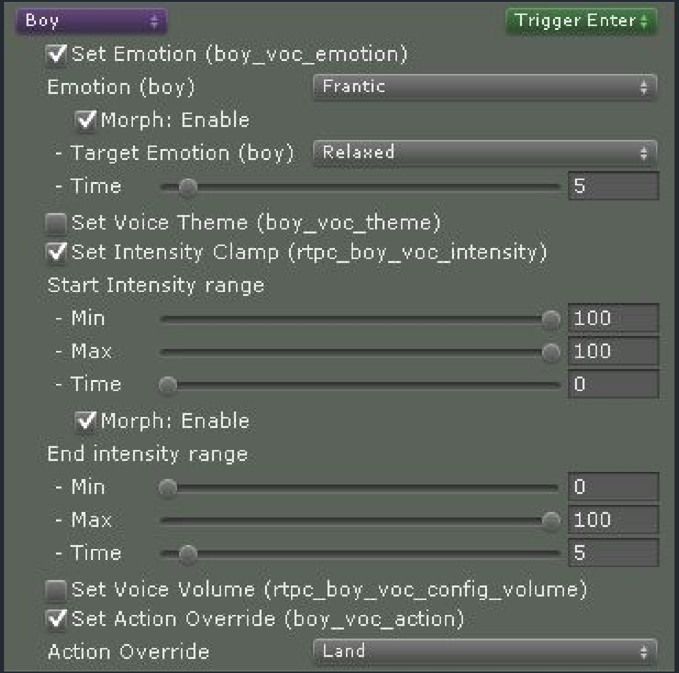
engaged active

Voice Sequencer Configuration

- Trigger boxes
- State machines
- Scripts
- Gives full control over voice parameters

Voice Sequencer Configuration: Trigger box





☑ Set Emotion (boy_voc_emotion)

Emotion (boy): Frantic

☑ Morph: Enable

- Target Emotion (boy): Relaxed

- Time: 5

□ Set Voice Theme (boy_voc_theme)

☑ Set Intensity Clamp (rtpc_boy_voc_intensity)

Start Intensity range

- Min: 100

- Max: 100

- Time: 0

☑ Morph: Enable

End intensity range

- Min: 0

- Max: 100

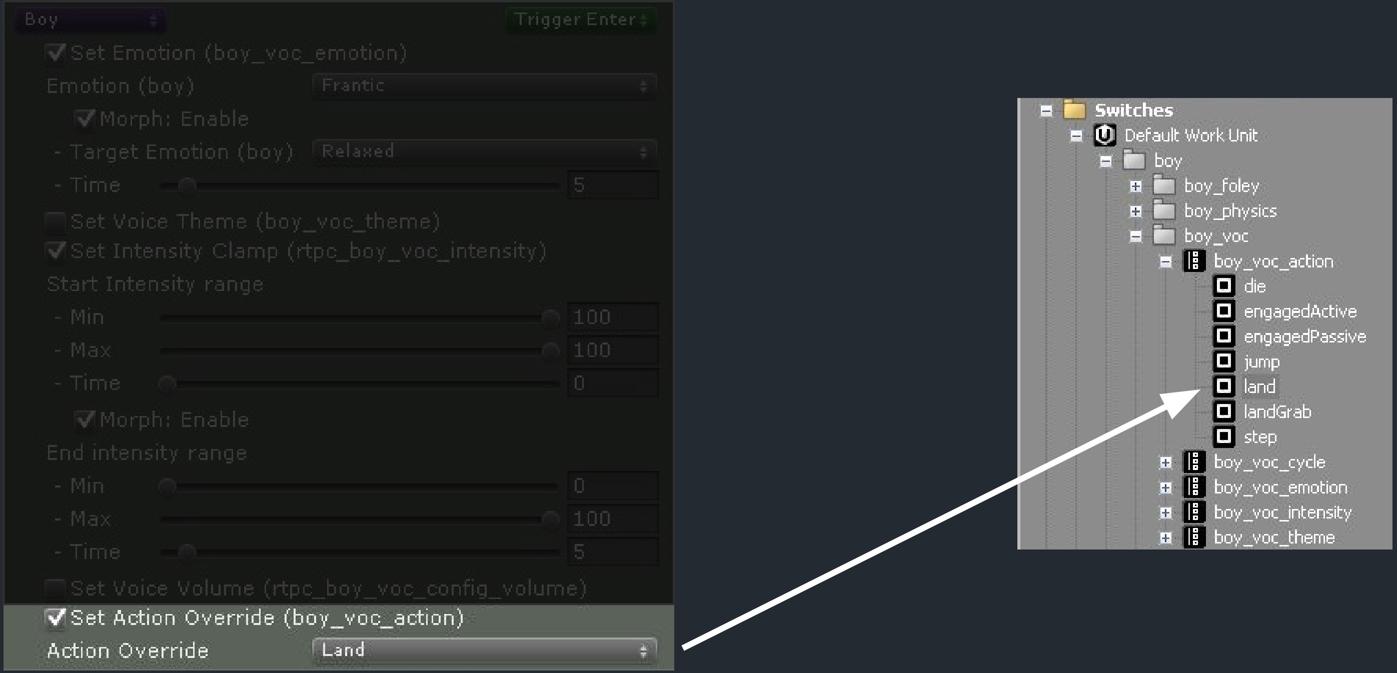
- Time: 5

□ Set Voice Volume (rtpc_boy_voc_config_volume)

☑ Set Action Override (boy_voc_action)

Action Override: Land

Switch



Boy | Trigger Enter

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☑ Morph: Enable

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- Time: 5

□ Set Voice Theme (boy_voc_theme)

☑ Set Intensity Clamp (rtpc_boy_voc_intensity)

Start Intensity range

- Min: 100

- Max: 100

- Time: 0

☑ Morph: Enable

End intensity range

- Min: 0

- Max: 100

- Time: 5

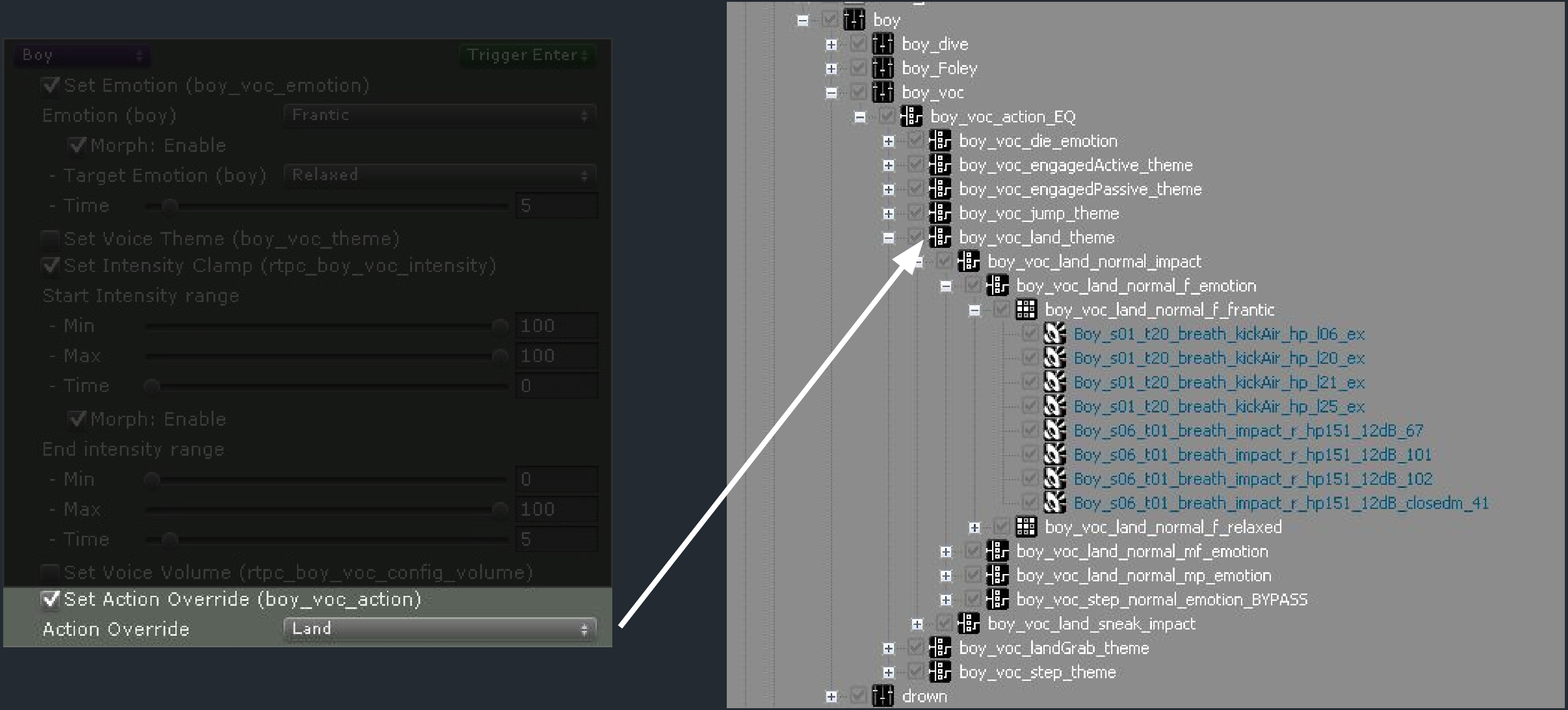
□ Set Voice Volume (rtpc_boy_voc_config_volume)

☑ Set Action Override (boy_voc_action)

Action Override: Land

- Switches
  - Default Work Unit
    - boy
      - boy_foley
      - boy_physics
      - boy_voc
        - boy_voc_action
          - die
          - engagedActive
          - engagedPassive
          - jump
          - land
          - landGrab
          - step
        - boy_voc_cycle
        - boy_voc_emotion
        - boy_voc_intensity
        - boy_voc_theme

Switch Container: Action



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- Time: 5

□ Set Voice Theme (boy_voc_theme)

☑ Set Intensity Clamp (rtpc_boy_voc_intensity)

Start Intensity range

- Min: 100
- Max: 100
- Time: 0

☑ Morph: Enable

End intensity range

- Min: 0
- Max: 100
- Time: 5

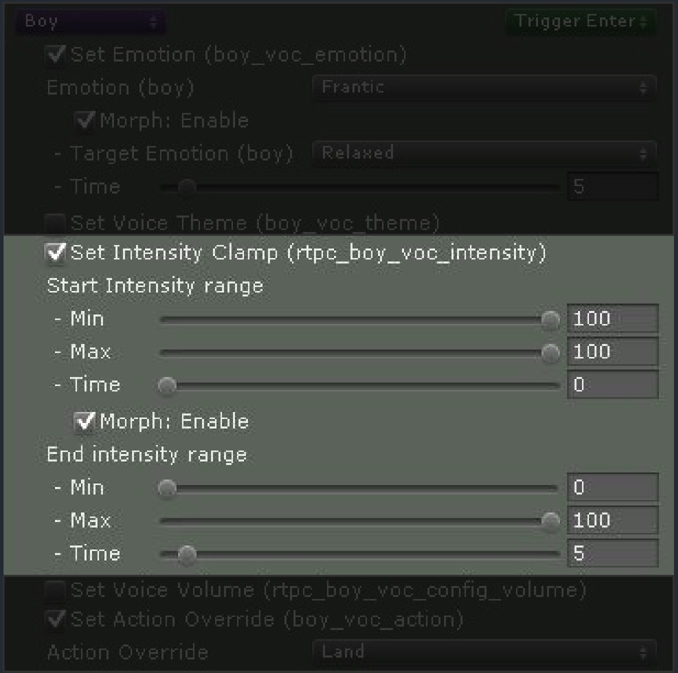
□ Set Voice Volume (rtpc_boy_voc_config_volume)

☑ Set Action Override (boy_voc_action)

Action Override: Land

```
boy
  boy_dive
  boy_Foley
  boy_voc
    boy_voc_action_EQ
      boy_voc_die_emotion
      boy_voc_engagedActive_theme
      boy_voc_engagedPassive_theme
      boy_voc_jump_theme
      boy_voc_land_theme
        boy_voc_land_normal_impact
          boy_voc_land_normal_f_emotion
            boy_voc_land_normal_f_frantic
              Boy_s01_t20_breath_kickAir_hp_l06_ex
              Boy_s01_t20_breath_kickAir_hp_l20_ex
              Boy_s01_t20_breath_kickAir_hp_l21_ex
              Boy_s01_t20_breath_kickAir_hp_l25_ex
              Boy_s06_t01_breath_impact_r_hp151_12dB_67
              Boy_s06_t01_breath_impact_r_hp151_12dB_101
              Boy_s06_t01_breath_impact_r_hp151_12dB_102
              Boy_s06_t01_breath_impact_r_hp151_12dB_closedm_41
            boy_voc_land_normal_f_relaxed
          boy_voc_land_normal_mf_emotion
          boy_voc_land_normal_mp_emotion
          boy_voc_step_normal_emotion_BYPASS
        boy_voc_land_sneak_impact
      boy_voc_landGrab_theme
      boy_voc_step_theme
  drown
```

Switch Container: Intensity



Boy | Trigger Enter

☑ Set Emotion (boy_voc_emotion)

Emotion (boy) Frantic

☑ Morph: Enable

- Target Emotion (boy) Relaxed

- Time 5

□ Set Voice Theme (boy_voc_theme)

☑ Set Intensity Clamp (rtpc_boy_voc_intensity)

Start Intensity range

- Min 100
- Max 100
- Time 0

☑ Morph: Enable

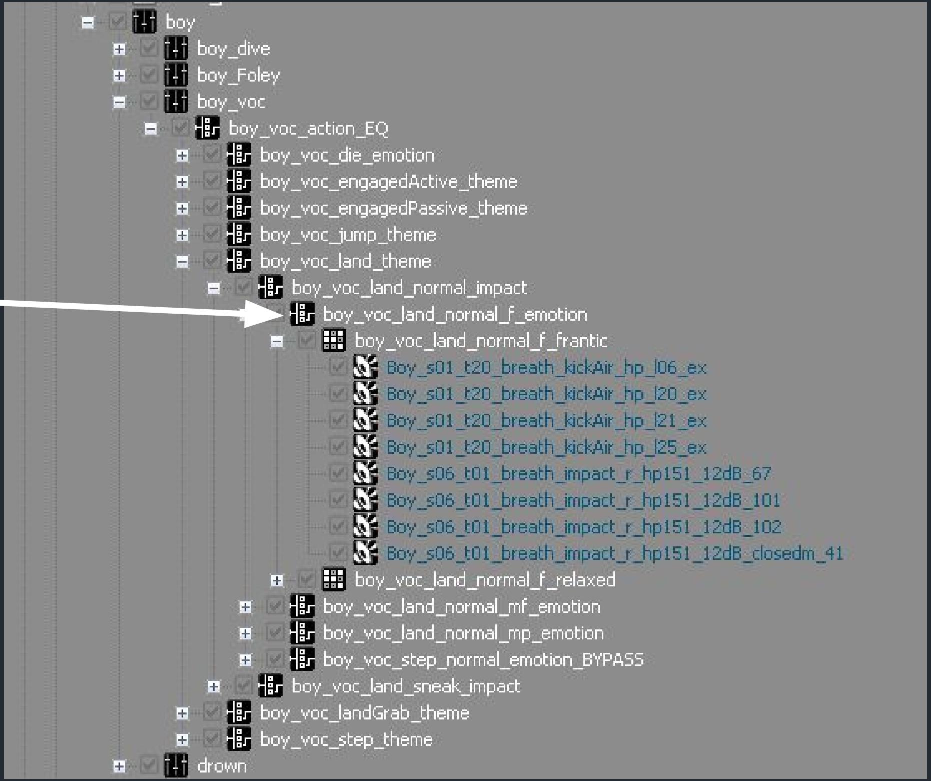
End intensity range

- Min 0
- Max 100
- Time 5

□ Set Voice Volume (rtpc_boy_voc_config_volume)

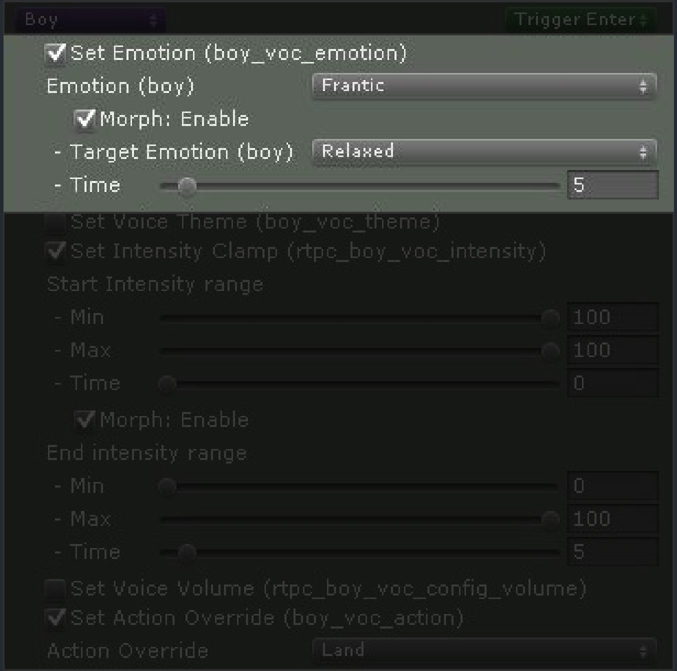
☑ Set Action Override (boy_voc_action)

Action Override Land



```
boy
  boy_dive
  boy_Foley
  boy_voc
    boy_voc_action_EQ
      boy_voc_die_emotion
      boy_voc_engagedActive_theme
      boy_voc_engagedPassive_theme
      boy_voc_jump_theme
      boy_voc_land_theme
        boy_voc_land_normal_impact
          boy_voc_land_normal_f_emotion
            boy_voc_land_normal_f_frantic
              Boy_s01_t20_breath_kickAir_hp_l06_ex
              Boy_s01_t20_breath_kickAir_hp_l20_ex
              Boy_s01_t20_breath_kickAir_hp_l21_ex
              Boy_s01_t20_breath_kickAir_hp_l25_ex
              Boy_s06_t01_breath_impact_r_hp151_12dB_67
              Boy_s06_t01_breath_impact_r_hp151_12dB_101
              Boy_s06_t01_breath_impact_r_hp151_12dB_102
              Boy_s06_t01_breath_impact_r_hp151_12dB_closedm_41
            boy_voc_land_normal_f_relaxed
          boy_voc_land_normal_mf_emotion
          boy_voc_land_normal_mp_emotion
          boy_voc_step_normal_emotion_BYPASS
        boy_voc_land_sneak_impact
      boy_voc_landGrab_theme
      boy_voc_step_theme
  drown
```

Switch Container: Emotion



Boy ⬍ Trigger Enter ⬍

☑ Set Emotion (boy_voc_emotion)

Emotion (boy) Frantic

☑ Morph: Enable

- Target Emotion (boy) Relaxed
- Time 5

□ Set Voice Theme (boy_voc_theme)

☑ Set Intensity Clamp (rtpc_boy_voc_intensity)

Start Intensity range

- Min 100
- Max 100
- Time 0

☑ Morph: Enable

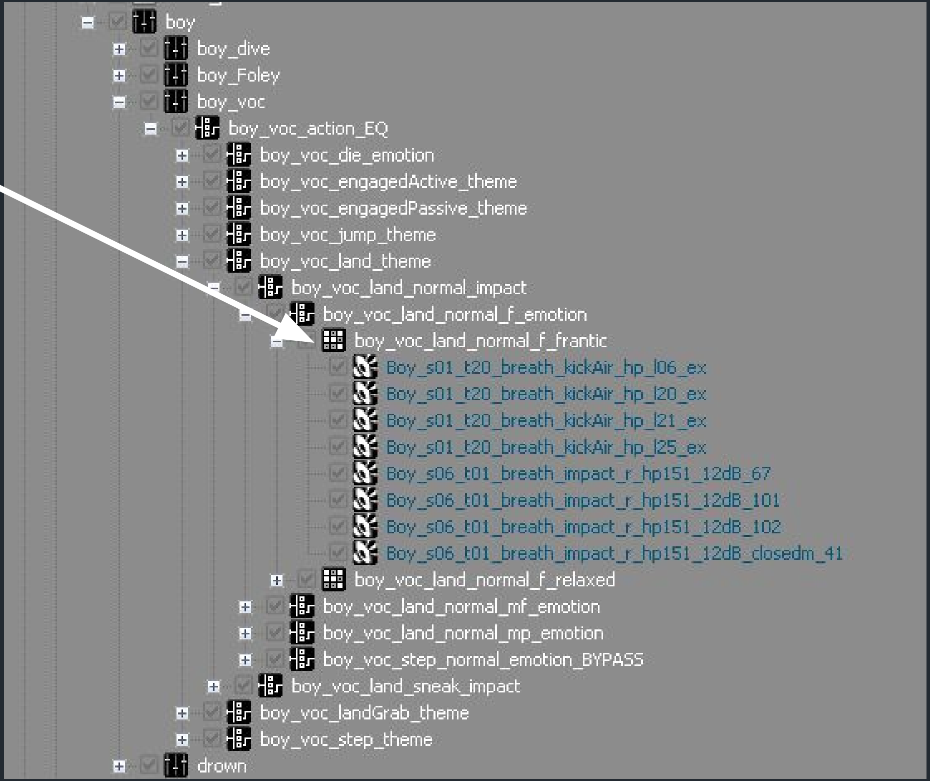
End intensity range

- Min 0
- Max 100
- Time 5

□ Set Voice Volume (rtpc_boy_voc_config_volume)

☑ Set Action Override (boy_voc_action)

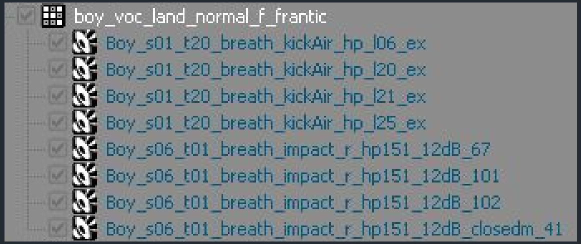
Action Override Land



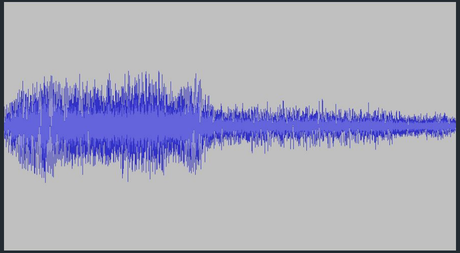
```
boy
  boy_dive
  boy_Foley
  boy_voc
    boy_voc_action_EQ
      boy_voc_die_emotion
      boy_voc_engagedActive_theme
      boy_voc_engagedPassive_theme
      boy_voc_jump_theme
      boy_voc_land_theme
        boy_voc_land_normal_impact
          boy_voc_land_normal_f_emotion
            boy_voc_land_normal_f_frantic
              Boy_s01_t20_breath_kickAir_hp_l06_ex
              Boy_s01_t20_breath_kickAir_hp_l20_ex
              Boy_s01_t20_breath_kickAir_hp_l21_ex
              Boy_s01_t20_breath_kickAir_hp_l25_ex
              Boy_s06_t01_breath_impact_r_hp151_12dB_67
              Boy_s06_t01_breath_impact_r_hp151_12dB_101
              Boy_s06_t01_breath_impact_r_hp151_12dB_102
              Boy_s06_t01_breath_impact_r_hp151_12dB_closedm_41
            boy_voc_land_normal_f_relaxed
          boy_voc_land_normal_mf_emotion
          boy_voc_land_normal_mp_emotion
          boy_voc_step_normal_emotion_BYPASS
        boy_voc_land_sneak_impact
      boy_voc_landGrab_theme
      boy_voc_step_theme
drown
```

Random Container

Randomly selects and plays one of its children sounds

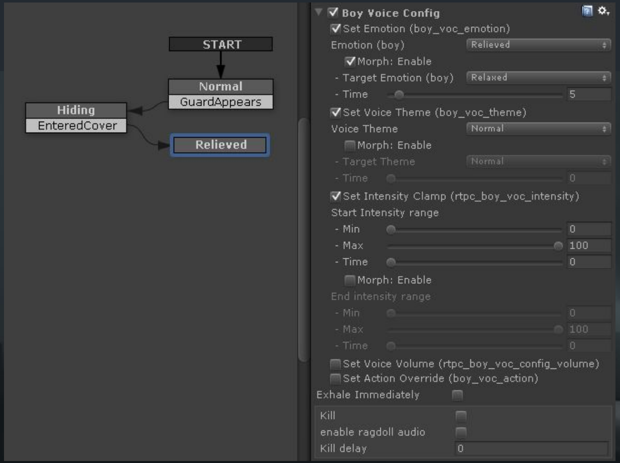


```
boy_voc_land_normal_f_frantic
    Boy_s01_t20_breath_kickAir_hp_l06_ex
    Boy_s01_t20_breath_kickAir_hp_l20_ex
    Boy_s01_t20_breath_kickAir_hp_l21_ex
    Boy_s01_t20_breath_kickAir_hp_l25_ex
    Boy_s06_t01_breath_impact_r_hp151_12dB_67
    Boy_s06_t01_breath_impact_r_hp151_12dB_101
    Boy_s06_t01_breath_impact_r_hp151_12dB_102
    Boy_s06_t01_breath_impact_r_hp151_12dB_closedm_41
```



Voice Direction

- Voice configuration is our way of doing voice direction.
- The director (Martin) instructs the actor (voice sequencer) how to emote:
  - based on location on the set (trigger boxes), or
  - based on reacting to events (state machines or scripts)



☑ Boy Voice Config

☑ Set Emotion (boy_voc_emotion)
Emotion (boy) Relieved
☑ Morph: Enable
- Target Emotion (boy) Relaxed
- Time 5

☑ Set Voice Theme (boy_voc_theme)
Voice Theme Normal
☐ Morph: Enable
- Target Theme Normal
- Time 0

☑ Set Intensity Clamp (rtpc_boy_voc_intensity)
Start Intensity range
- Min 0
- Max 100
- Time 0
☐ Morph: Enable
End intensity range
- Min 0
- Max 100
- Time 0

☐ Set Voice Volume (rtpc_boy_voc_config_volume)
☐ Set Action Override (boy_voc_action)
Exhale Immediately ☐

Kill ☐
enable ragdoll audio ☐
Kill delay 0

Voice Sequencer

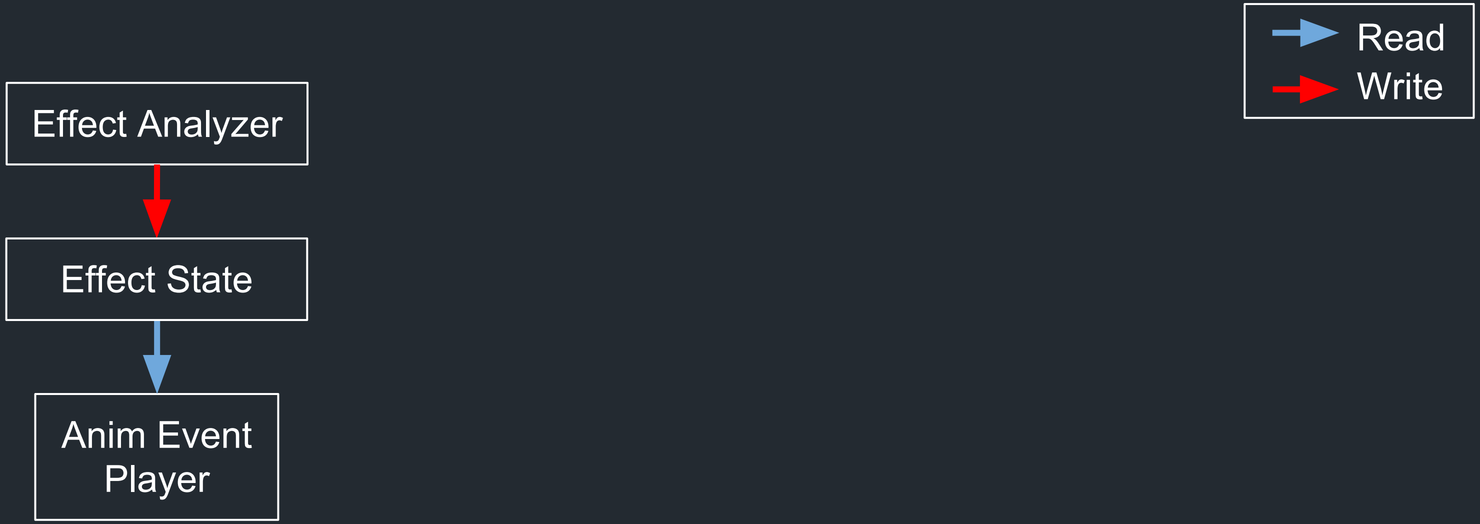
Video: voice.mp4

Voice Sequencer Summary

- Sound events are selected based on action, emotion, intensity, etc.
- Continuous sequencing of sound events
- Voice direction with trigger boxes and state machines

Wrapping Up

Animation Events



Effect Analyzer

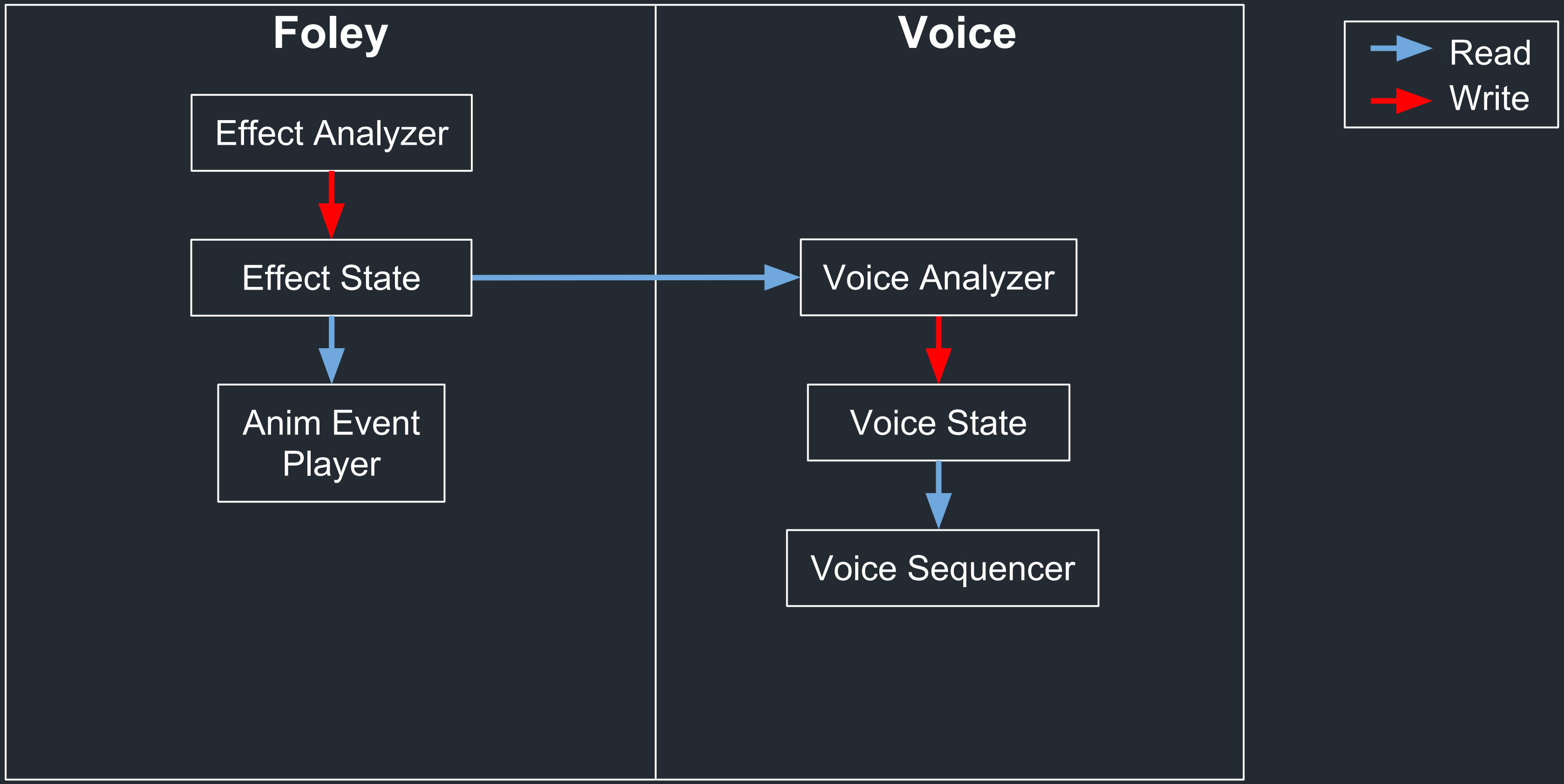
Effect State

Anim Event Player

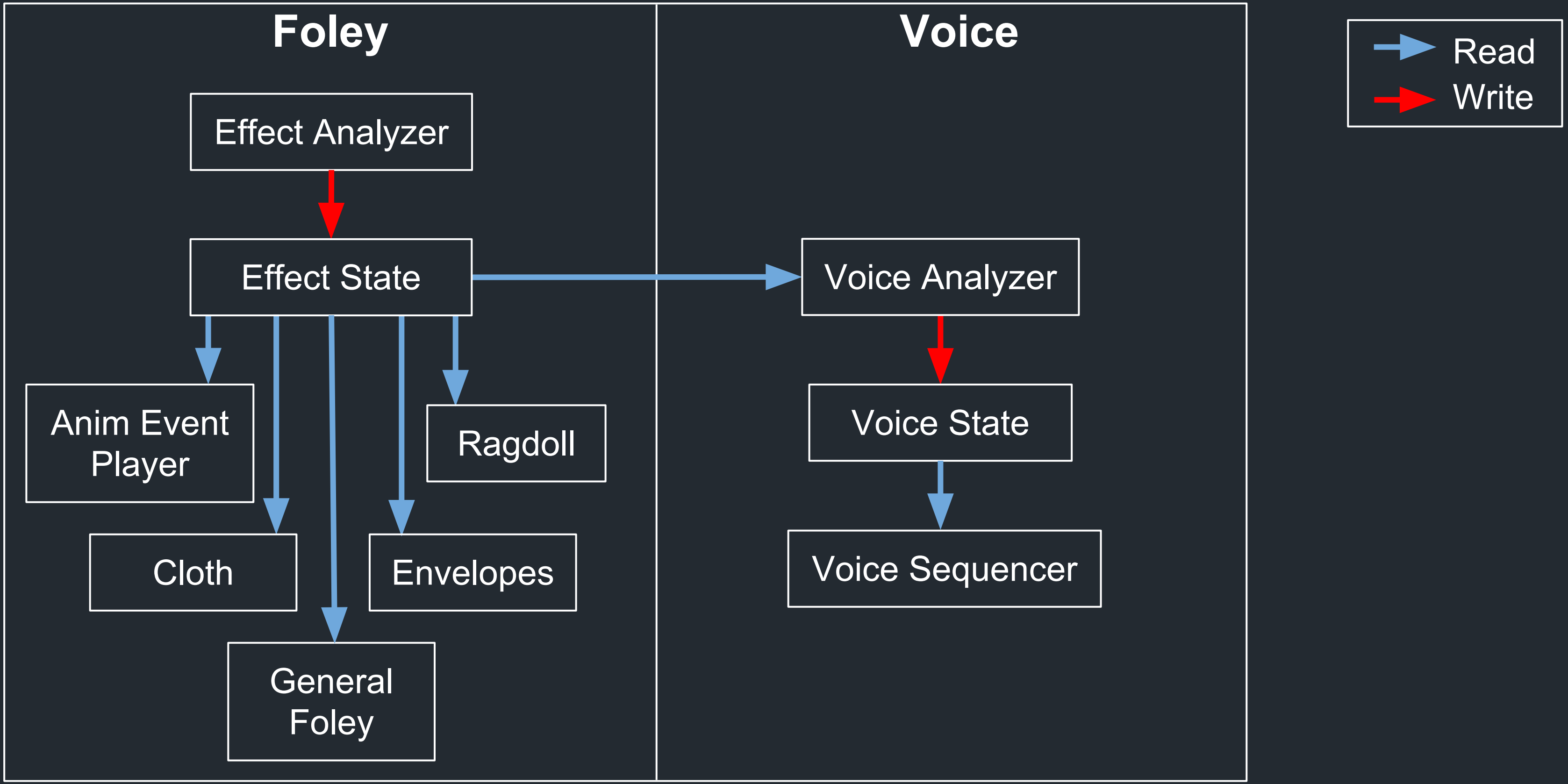
Read

Write

Voice Sequencer



Full Audio Architecture for the Boy

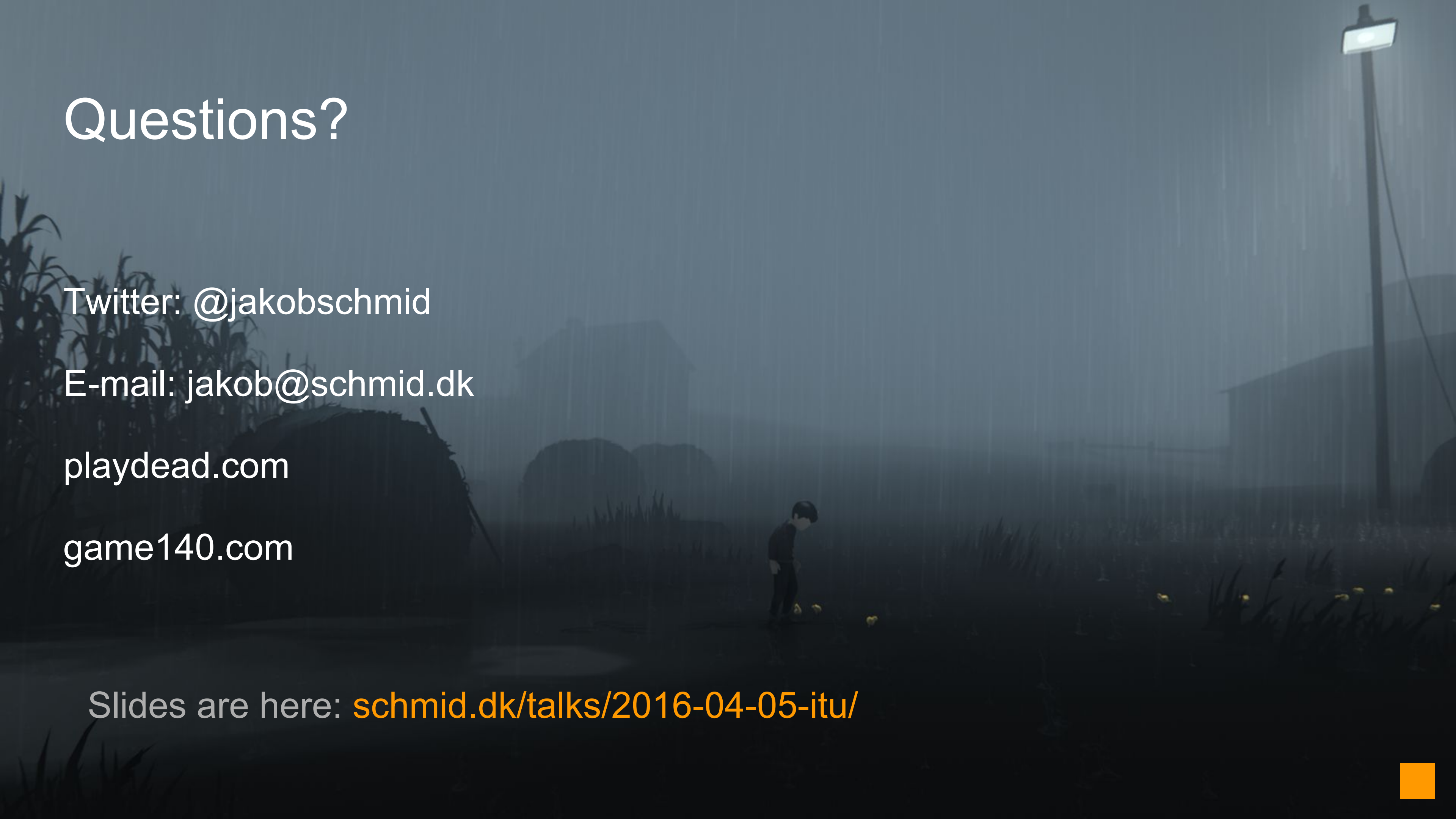


Using Wwise for Your Own Projects

- Free for non-commercial use (limited to 200 sounds)
- Has Unity integration
- Setup is not completely trivial
- Using the Authoring Tool requires training
- The Authoring Tool is very powerful without having to code
- Short answer: Maybe.

www.audiokinetic.com/download/

Questions?



Twitter: @jakobschmid

E-mail: jakob@schmid.dk

playdead.com

game140.com

Slides are here: schmid.dk/talks/2016-04-05-itu/

Column Default

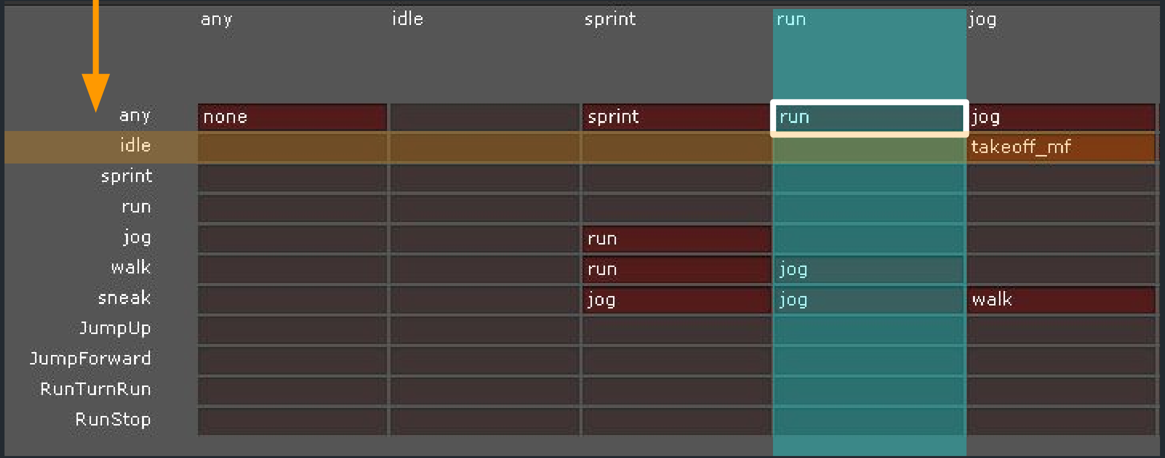
- Empty entries are replaced with column default

idle

run

previous key: idle

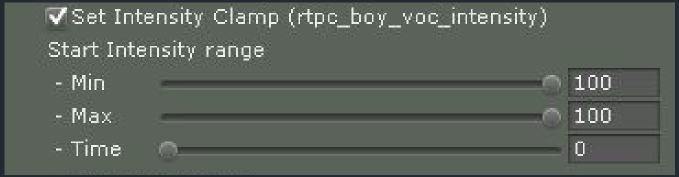
current key: run



	any	idle	sprint	run	jog
any	none		sprint	run	jog
idle					takeoff_mf
sprint					
run					
jog			run		
walk			run	jog	
sneak			jog	jog	walk
JumpUp					
JumpForward					
RunTurnRun					
RunStop					

play sound 'run'

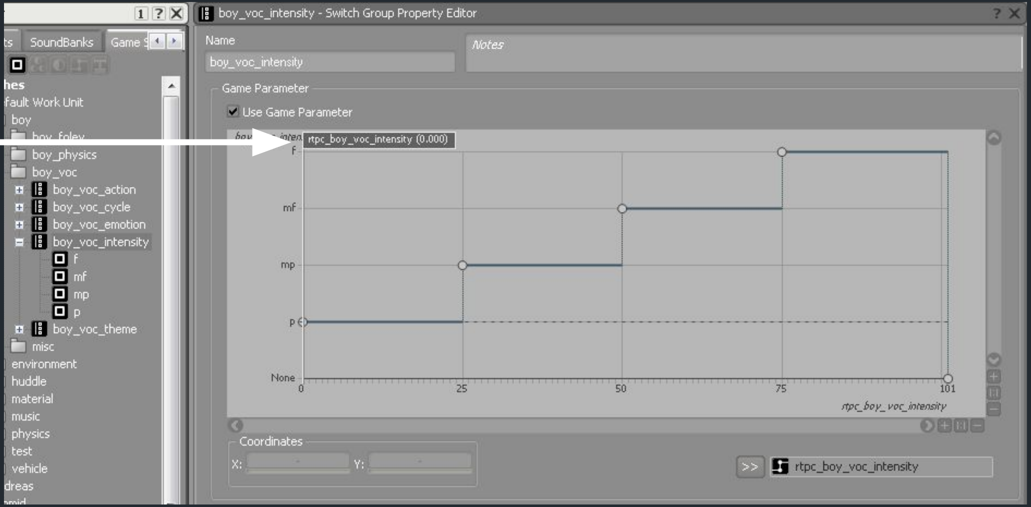
Switch Controlled by Parameter



☑ Set Intensity Clamp (rtpc_boy_voc_intensity)

Start Intensity range

- Min 100
- Max 100
- Time 0



boy_voc_intensity - Switch Group Property Editor

Name: boy_voc_intensity

Notes

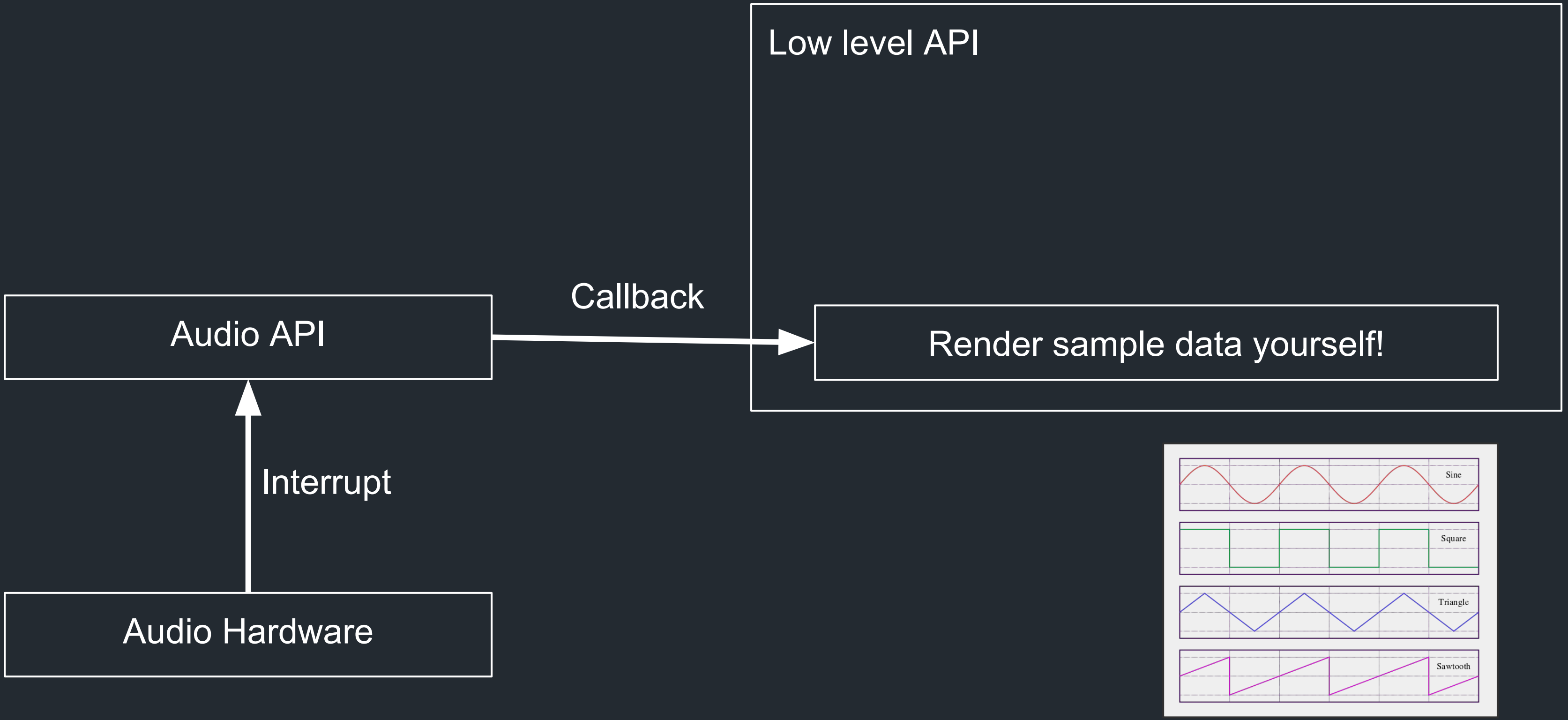
Game Parameter

☑ Use Game Parameter

rtpc_boy_voc_intensity (0.000)

>> rtpc_boy_voc_intensity

Audio Engine Overview: Low-level



Low level API

Audio API

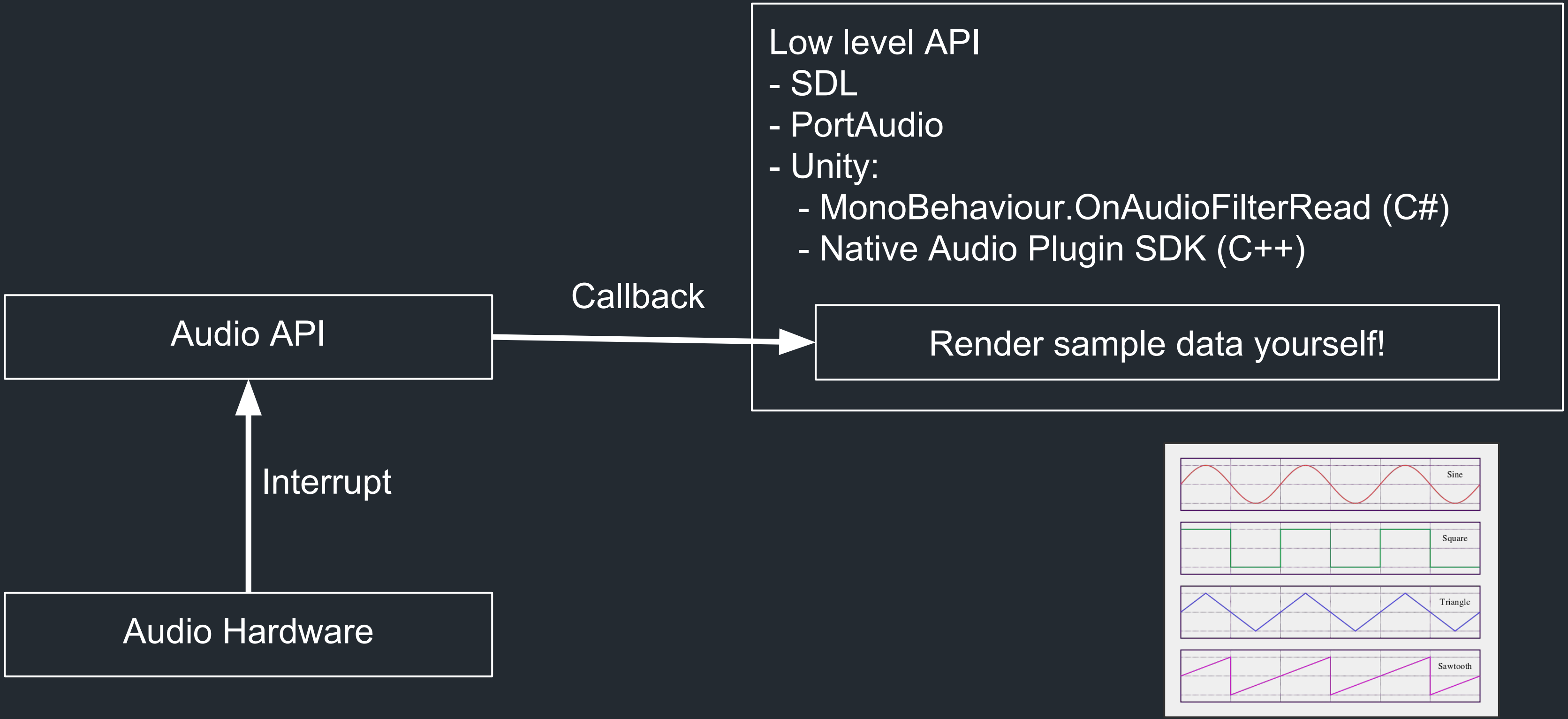
Callback

Render sample data yourself!

Interrupt

Audio Hardware

Audio Engine Overview: Low-level



Low level API
- SDL
- PortAudio
- Unity:
  - MonoBehaviour.OnAudioFilterRead (C#)
  - Native Audio Plugin SDK (C++)

Render sample data yourself!

Callback

Audio API

Interrupt

Audio Hardware