# Crackdown 3: Music And Sound
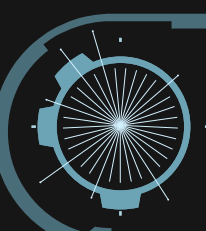
Finishing Move, Inc. & Kristofor Mellroth

# The Music of Crackdown 3

- Composing strategies for large open worlds
- Staying organized across thousands of assets
- Benefits of Composer Implementation

Scoring the Island of New Providence

# The Challenge

- ## Music in an Open World
  - Music in a large, nonlinear open world is hard
  - Where do we need/want music to support gameplay?
  - What is that music themed around, what story do we want to tell?

- ## Music Interactivity
  - What kind and how much interactivity do we need/want?
  - How can we achieve that within the framework/logic we have?

- ## Music Style
  - What do Crackdown and its characters sound like?
  - Licensed music vs. all original score

CRACKDOWN
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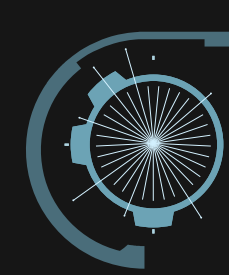
# Nailing The "Neighborhood Sound"

- ## Cinematic Cyber Trap
  - Inspiration: Modern hip-hop/trap, film trailers, musical sound design.
  - Bosses each have a unique theme based on personality and style
  - Initial sketches were written as complete tracks before being digested into interactive assets.

- ## All original score
  - Achieve coherency within the world
  - Increase interactivity potential
  - Avoid music licensing risks

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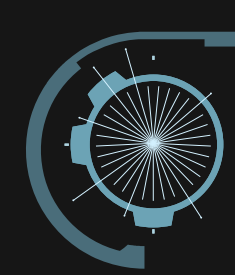
# Open World Approach

- One big map, completely non-linear story

- All about that (boss) base
  - Each boss controls certain assets/zones in the world
  - Each boss has a set of "missions" the player needs to complete to draw out the boss
  - 9 bosses total (1 Kingpin > 3 Captains > 5 Lieutenants)

- Music to Inform / Music to Reward "who won, who lost"
  - Music is NOT persistent in the world
  - Boss themed music informs player when they enter mission areas / scales up as you draw out/fight each boss
  - Agency themed music rewards player for accomplishments

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**VISION**

**POWER**

**PEACE**

**ORDER**

TERRANOVA
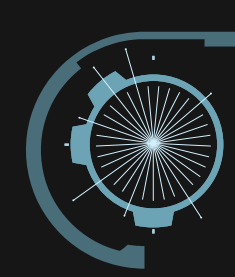INCORPORATED

TERRANOVA
INDUSTRY

TERRANOVA
SECURITY

TERRANOVA
LOGISTICS

# Mission / Zone Music Breakdown

- 2 x Sets of Ambient Loops (high/low)

- 3 x Sets of Combat Loops (low/med/high)

- Low Health, Death, DBNO Loops/Stingers

- 10-15 Zone Notification Stingers (Area Enter, Objective Complete, "Eyes On")

- 3-8 x Final Boss Battle Loops (scripted by design)
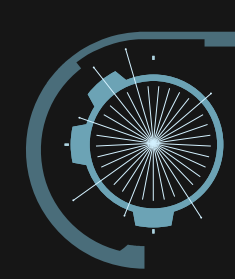
- Boss Narrative Sequences Scored to Picture

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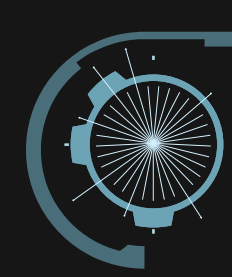
# Additional Interactive Systems

- Captain Reinforcement – CPT music takes over
    - Interactive based on "Hate Meter"

- Kingpin Lockdown – KP music takes over
    - Win or Die

- Propaganda Towers
    - Vertical interactivity

- Road/Rooftop Races

CRACKDOWN
3

# Diagetic World Music

- Shop and Businesses have short non-looping jingles

- Nightclubs/Boomboxes have themed ambient looping music

- Over 50+ unique jingles/loops fill the world adding color and humor
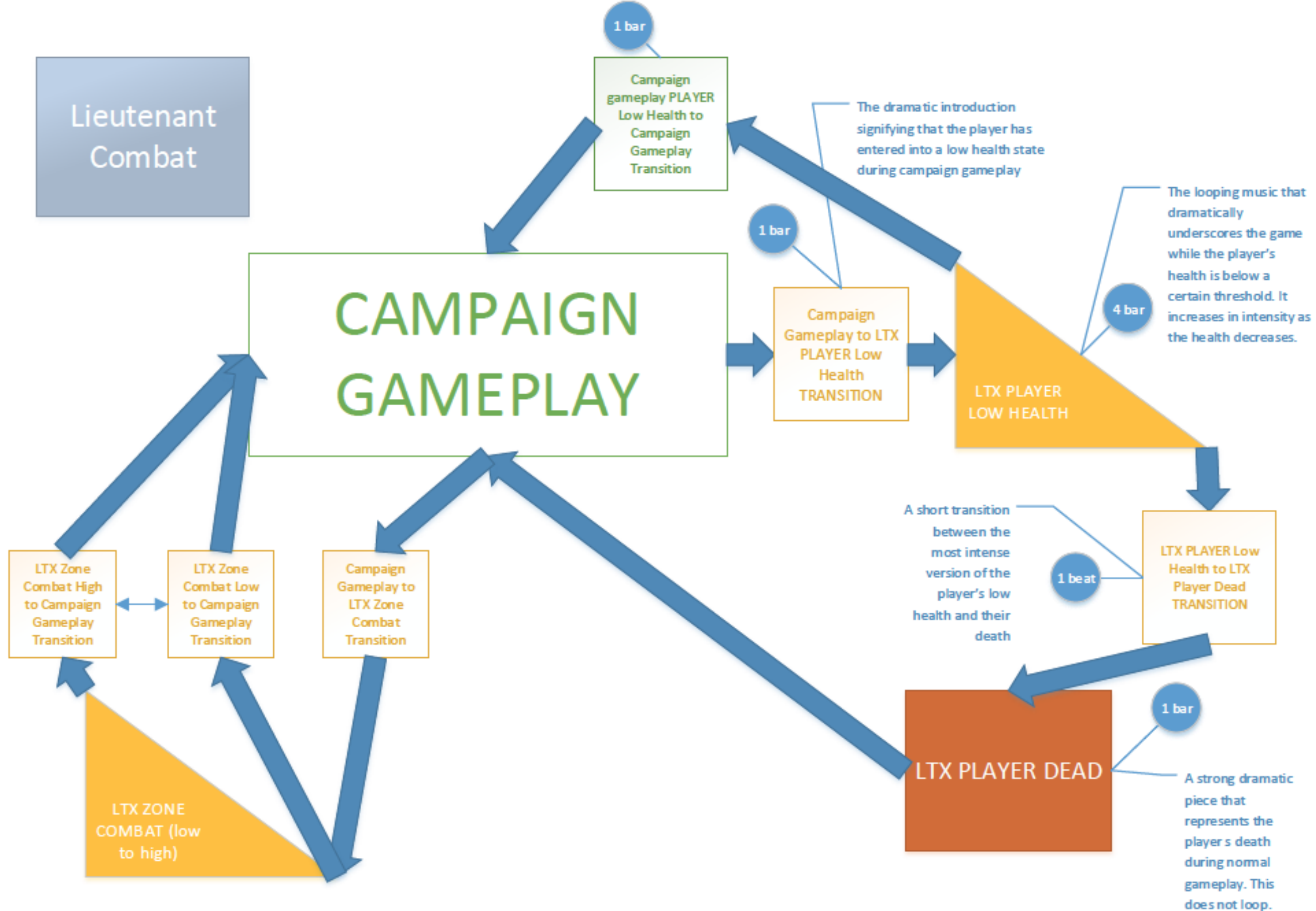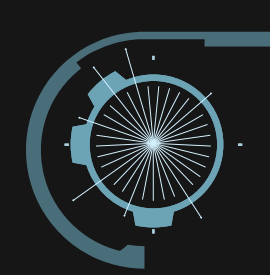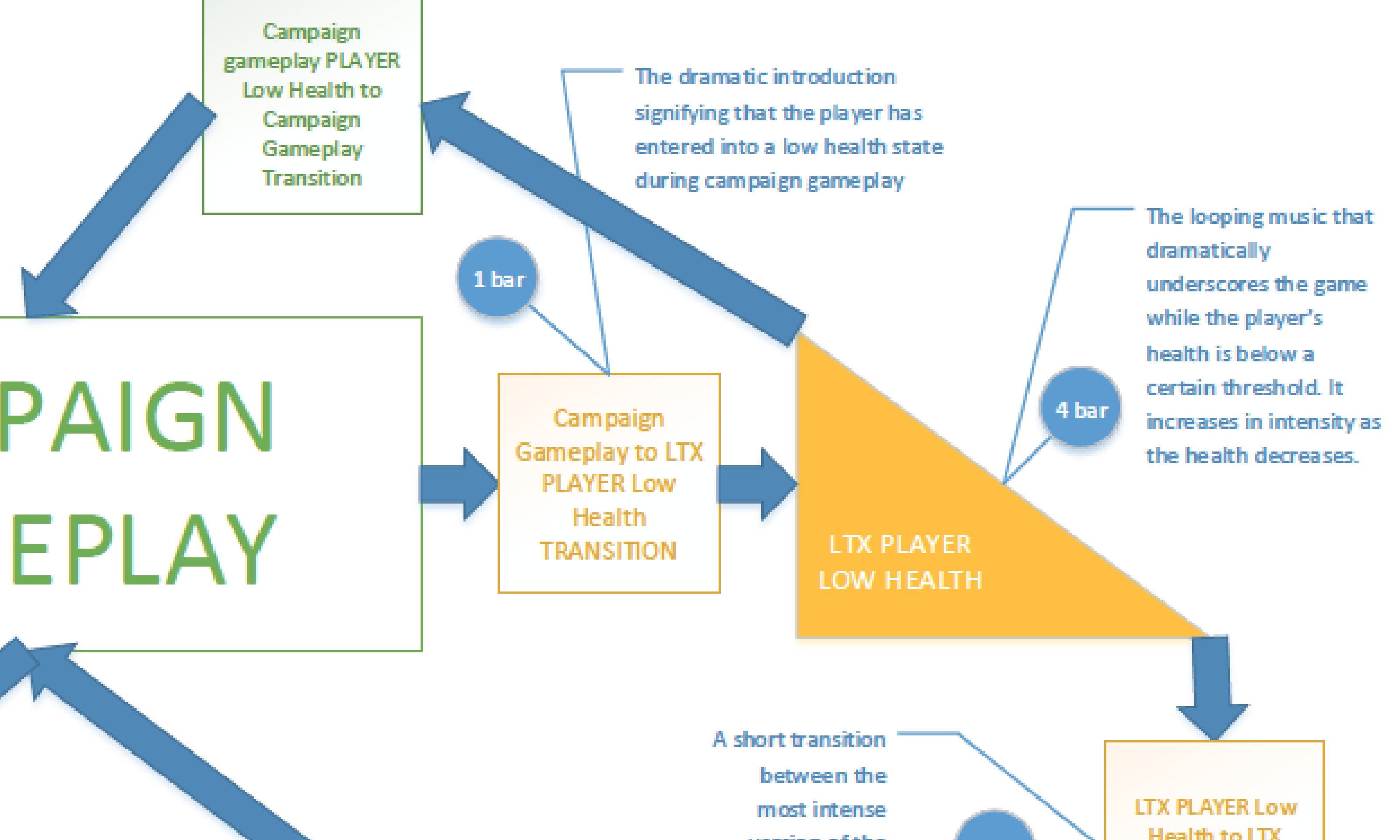
CRACKDOWN
3

# Staying Organized

# Music System Design/Organization

- Almost 4 hours of music across thousands of assets over 4+ years in development

- 3 Tier Approach to design and organization
  - Visio flow charts provide interactive design and flow
  - P4 Synced, color coded "tracker" spreadsheets provide consolidated asset/implementation/code tracking
  - Organization of Assets in Wwise

CRACKDOWN 3

Campaign gameplay PLAYER Low Health to Campaign Gameplay Transition

The dramatic introduction signifying that the player has entered into a low health state during campaign gameplay

1 bar

PAIGN EPLAY

Campaign Gameplay to LTX PLAYER Low Health TRANSITION

The looping music that dramatically underscores the game while the player's health is below a certain threshold. It increases in intensity as the health decreases.

4 bar

LTX PLAYER LOW HEALTH

A short transition between the most intense

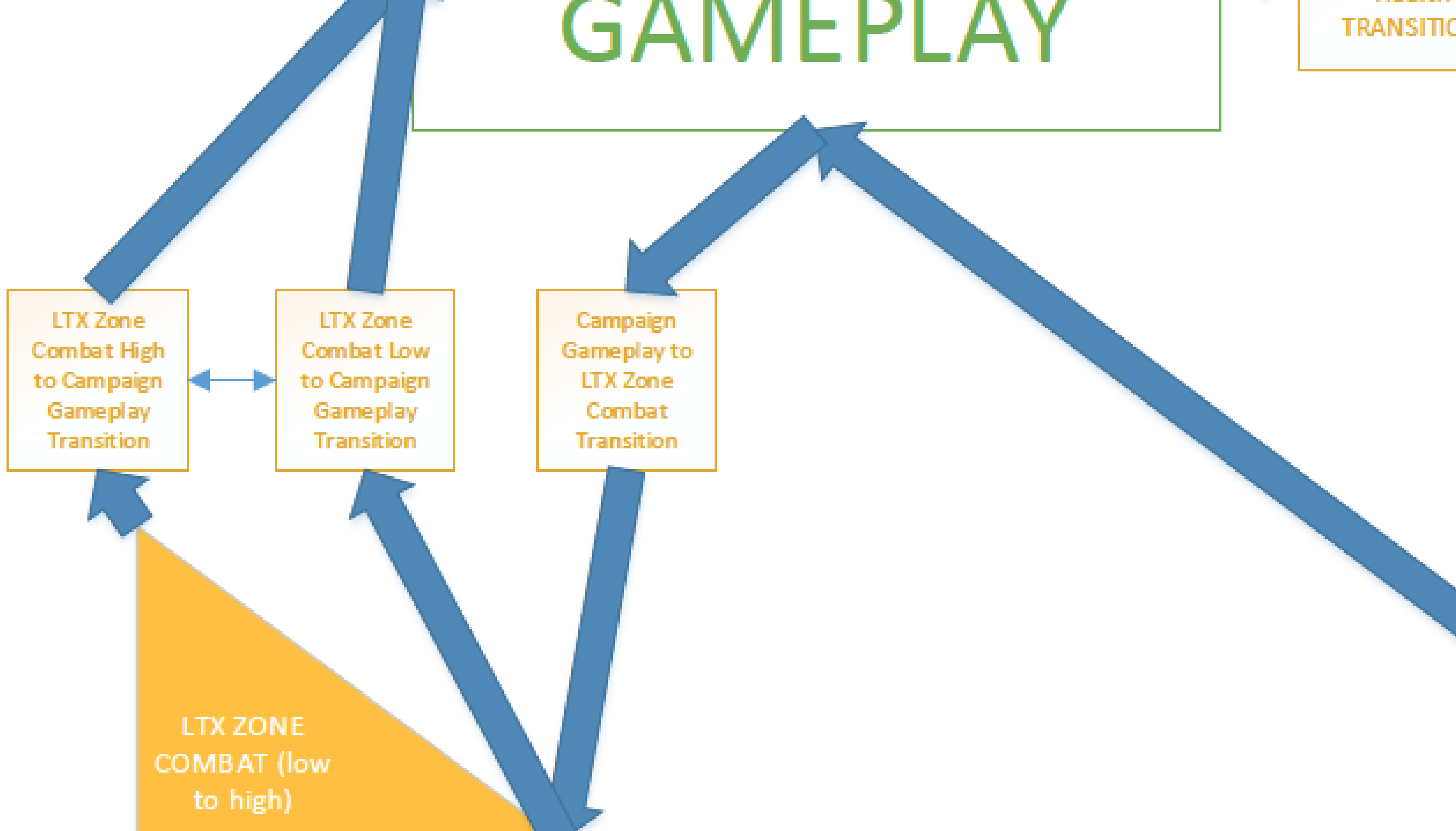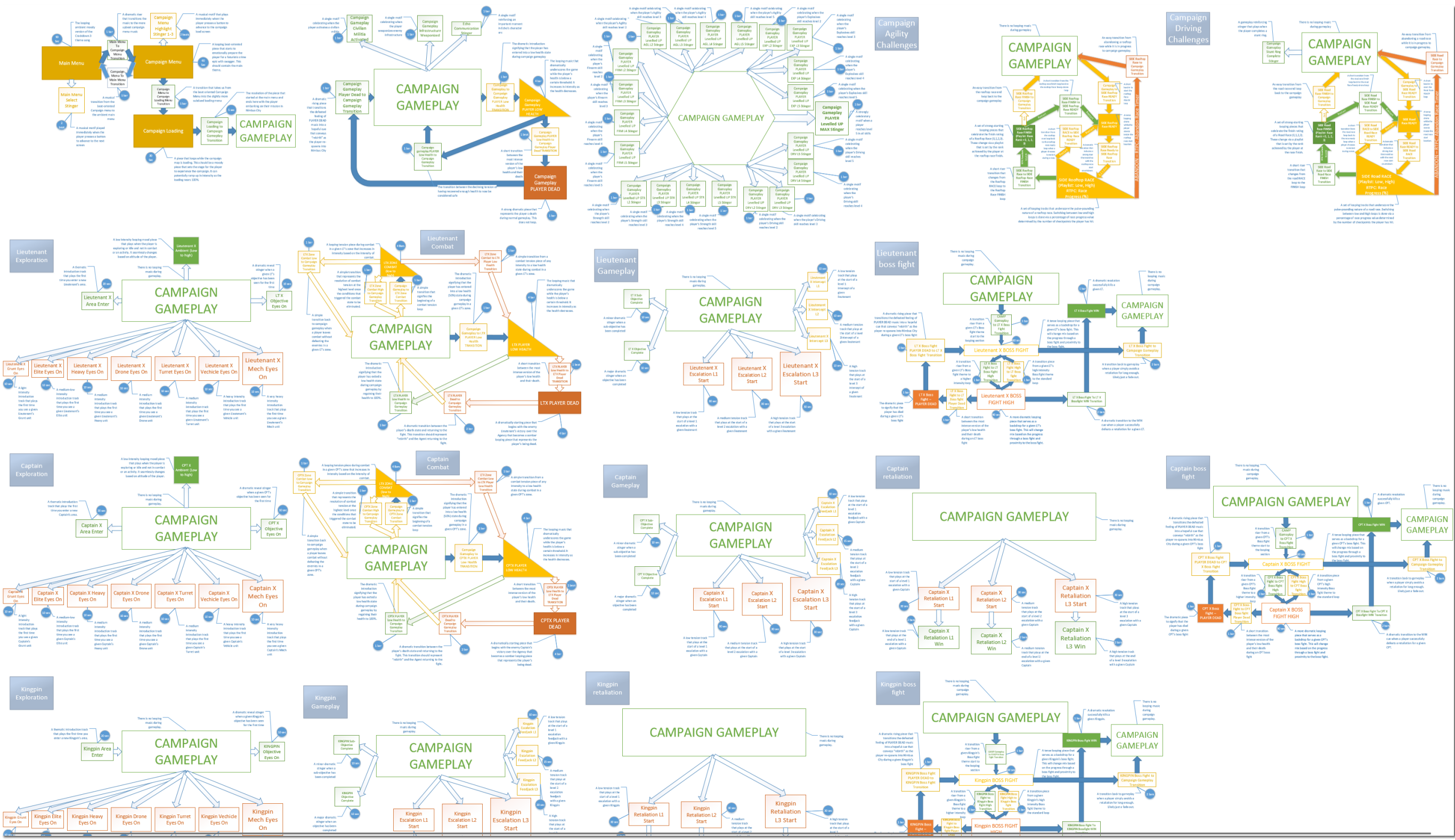LTX PLAYER Low Health to LTX

GAMEPLAY

TRANSITION

LTX Zone
Combat High
to Campaign
Gameplay
Transition

LTX Zone
Combat Low
to Campaign
Gameplay
Transition

Campaign
Gameplay to
LTX Zone
Combat
Transition

LTX ZONE
COMBAT (low
to high)

F5 | MUS_SIDE_Rooftop_Race_Loop_Low

| Trigger | Filename | Est Duration (s) | Wwise | Content | Code | Notes | Implementation Details |
|---|---|---|---|---|---|---|---|
| N/A | MUS_CAMP_Gameplay_To_SIDE_Rooftop_Race_Ready_Transition | 2 | | | N/A | A short lead-in to start the rooftop Race READY loop | AAudioManager::UpdateAgentProxy |
| | MUS_SIDE_Rooftop_Race_Ready_Loop | 8 | | | Done | A tense looping drone while the player stands inside the rooftop race start location. | See MissionReadyMusic in BP_RaceMissionActor.uasset for de  Play MissionTestMap.umap  Console Command: Mission.UnlockAll |
| N/A | MUS_SIDE_Rooftop_Race_Ready_To_SIDE_Rooftop_Race_Transition | 2 | | | N/A | A dramatic transition that includes a strong riser that matches with the rooftop race start countdown. | See MissionInProgressMusic in BP_VehicleRaceMissionActor.u |
| | MUS_SIDE_Rooftop_Race_Loop_Low | 32 | | | Done | A low intensity looping track that underscore the pulse-pounding nature of a rooftop race. Switching between loops is done via a percentage of race progress value determined by the number of checkpoints the player has hit. | See MissionInProgressMusic in BP_RaceMissionActor.uasset fo  Play MissionTestMap.umap  Console Command: Mission.UnlockAll |
| | MUS_SIDE_Rooftop_Race_Loop_High | 32 | | | Done | A high intensity looping track that underscore the pulse-pounding nature of a rooftop race. Switching between loops is done via a percentage of race progress value determined by the number of checkpoints the player has hit. | See MissionInProgressMusic in BP_RaceMissionActor.uasset fo  Play MissionTestMap.umap  Console Command: Mission.UnlockAll |
| N/A | MUS_SIDE_Rooftop_Race_To_SIDE_Rooftop_Race_Ready_Transition | 2 | | | N/A | A short transition from the rooftop race loop back to the rooftop race ready loop when a player chooses to restart during a race. | See MissionFinishedMusic in BP_VehicleRaceMissionActor.ua |
| N/A | MUS_SIDE_Rooftop_Race_To_SIDE_Rooftop_Race_Finish_Transition | 2 | | | N/A | A short riser transition that changes from the Rooftop RACE loop to the Rooftop Race FINISH loop | See MissionFinishedMusic in BP_VehicleRaceMissionActor.ua |
| N/A | MUS_SIDE_Rooftop_Race_To_CAMP_Gameplay_Transition | 2 | | | N/A | An easy transition from abandoning a rooftop race while it is in progress to campaign gameplay. | See MissionFinishedMusic in BP_VehicleRaceMissionActor.ua |
| | MUS_SIDE_Rooftop_Race_Finish_Loop_Rank_0 | 13 | | | Done | A set of strong-starting looping pieces that celebrate the finish rating of a Rooftop Race (0,1,2,3). These change via a playlist that is set by the rank achieved by the player at the rooftop race finish. | See MissionFinishedMusic in BP_RaceMissionActor.uasset for  Play MissionTestMap.umap  Console Command: Mission.UnlockAll |
| | MUS_SIDE_Rooftop_Race_Finish_Loop_Rank_1 | 13 | | | Done | A set of strong-starting looping pieces that celebrate the finish rating of a Rooftop Race (0,1,2,3). These change via a playlist that is set by the rank achieved by the player at the rooftop race finish. | See MissionFinishedMusic in BP_RaceMissionActor.uasset for  Play MissionTestMap.umap  Console Command: Mission.UnlockAll |
| | MUS_SIDE_Rooftop_Race_Finish_Loop_Rank_2 | 13 | | | Done | A set of strong-starting looping pieces that celebrate the finish rating of a Rooftop Race (0,1,2,3). These change via a playlist that is set by the rank achieved by the player at the rooftop race finish. | See MissionFinishedMusic in BP_RaceMissionActor.uasset for  Play MissionTestMap.umap  Console Command: Mission.UnlockAll |
| | MUS_SIDE_Rooftop_Race_Finish_Loop_Rank_3 | 13 | | | Done | A set of strong-starting looping pieces that celebrate the finish rating of a Rooftop Race (0,1,2,3). These change via a playlist that is set by the rank achieved by the player at the rooftop race finish. | See MissionFinishedMusic in BP_RaceMissionActor.uasset for  Play MissionTestMap.umap  Console Command: Mission.UnlockAll |
| N/A | MUS_SIDE_Rooftop_Race_Finish_To_CAMP_Gameplay_Transition | 2 | | | N/A | An easy transition from the rooftop race end loop back to the campaign gameplay | AAudioManager::UpdateAgentProxy |
| N/A | MUS_SIDE_Rooftop_Race_Finish_To_SIDE_Rooftop_Race_Ready_Transition | 2 | | | N/A | A short transition from the rooftop race finish loop back to the rooftop Race Ready drone loop | AAudioManager::UpdateAgentProxy |
| N/A | MUS_CAMP_Gameplay_To_SIDE_Road_Race_Ready_Transition | 2 | | | N/A | A short lead-in to start the road Race READY loop | AAudioManager::UpdateAgentProxy |
| | MUS_SIDE_Road_Race_Ready_Loop | 8 | | | Done | A tense looping drone while the player stands inside the road race start location. | See MissionReadyMusic in BP_VehicleRaceMissionActor.uasse  Play MissionTestMap.umap  Console Command: Mission.UnlockAll |
| N/A | MUS_SIDE_Road_Race_Ready_To_SIDE_Road_Race_Transition | 2 | | | N/A | A dramatic transition that includes a strong riser that matches with the road race start countdown. | AAudioManager::UpdateAgentProxy |
| | MUS_SIDE_Road_Race_Loop_Low | 32 | | | Done | A low intensity looping track that underscore the pulse-pounding nature of a road race. Switching between loops is done via a percentage of race progress value determined by the number of checkpoints the player has hit. | See MissionInProgressMusic in BP_VehicleRaceMissionActor.u  Play MissionTestMap.umap  Console Command: Mission.UnlockAll |
| | MUS_SIDE_Road_Race_Loop_High | 32 | | | Done | A high intensity looping track that underscore the pulse-pounding nature of a road race. Switching between loops is done via a percentage of race progress value determined by the number of checkpoints the player has hit. | See MissionInProgressMusic in BP_VehicleRaceMissionActor.u  Play MissionTestMap.umap  Console Command: Mission.UnlockAll |
| N/A | MUS_SIDE_Road_Race_To_SIDE_Road_Race_Ready_Transition | 2 | | | N/A | A short transition from the road race loop back to the road race ready loop when a player chooses to restart during a race. | AAudioManager::UpdateAgentProxy |
| N/A | MUS_SIDE_Road_Race_To_SIDE_Road_Race_Finish_Transition | 2 | | | N/A | A short riser transition that changes from the road RACE loop to the road Race FINISH loop | |
| N/A | MUS_SIDE_Road_Race_To_CAMP_Gameplay_Transition | 2 | | | N/A | An easy transition from abandoning a road race while it is in progress to campaign gameplay. | |

Sheets: SIDE_MISSIONS | CINEMATICS | CEREMONIES | WORLD_AMBIENT | MUSIC_PARAMETERS | MODA
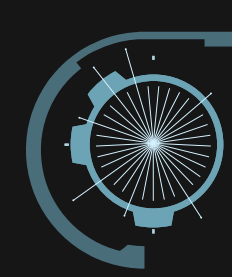
Composers in Wwise!

# Composers as Implementers

- Music system built in Wwise by Finishing Move

- Benefits
  - Gameplay/Soundcaster testing provides instant feedback and instructs composition process
  - Find and fix bugs quicker, react to design changes, etc.
  - Own the polish process completely

- Challenges
  - Syncing up with an international development pipeline can be complex
  - Tracking/keeping up with changes in design

# Key Takeaways (MUSIC)

- **Open world:** Composing for a large open world campaign requires a unique approach to interactive music design.

- **Organization:** In addition to asset spreadsheets, detailed flow charts / visual graphs of interactive state flow and transition possibilities are critical for complex music systems, for both the music team as well as the audio programmers and level designers.

- **Implementation:** Composers implementing their own score has distinct value in game development.
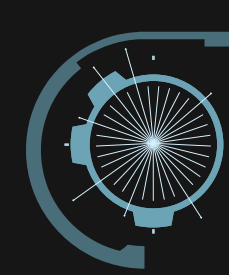
CRACKDOWN
3

# Sound and Mix Overview

- 5 more things we think are cool in Crackdown 3 that we would like to share with you here today.

    1. Acoustics
        - Cheap cost but sounds pretty good (nice!)
    2. Destruction
        - calculated on a server and rendered on a client (WTF?)
    3. Turbulence
        - How the system works (cool)
    4. LFE
        - Our philosophy on it (boring but useful)
    5. Mix
        - How we deal with so much chaos (interesting and useful)
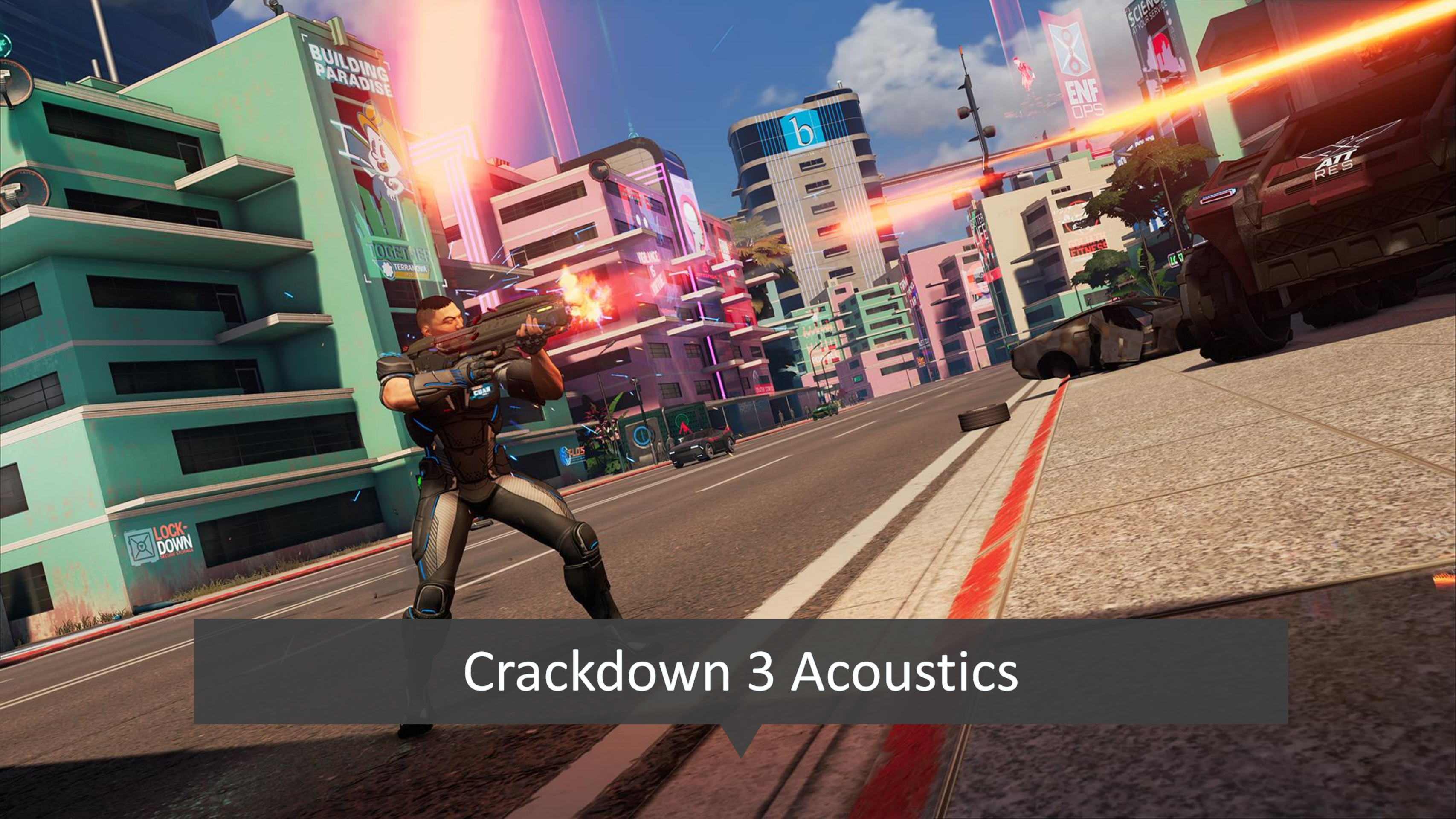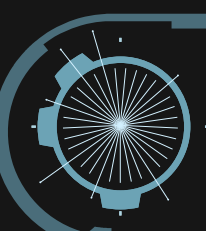
Crackdown 3 Acoustics

## Acoustics Goals

- Improved spatial awareness
- Convey urban environment
- Fully dynamic
- No custom plug-in
- No manual markup
- Not too noisy

# Acoustics Tech

- Raycasts – get distance values
  - Listener-relative, jittered & smoothed
- Game-defined sends
  - Directions (FL, FR, LS, RS, OH)
  - Interpolate between delays (5m, 10m, 15m, 20m, 30m, 40m, 50m)

- User-Defined Sends…
  - Game-defined sends to "Close" convolution reverb
  - Actors-Mixers send to "Distant convolution reverb

- RTPCs
  - [XDirection]_Distance, [Endpoint]_Active, Space_Volume
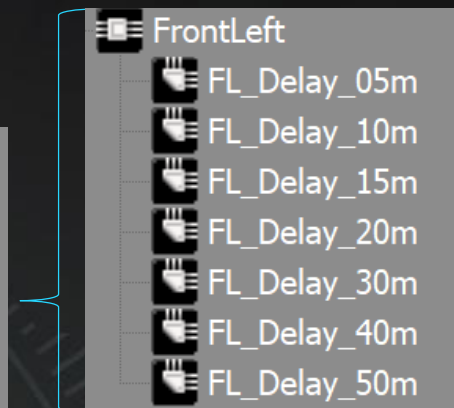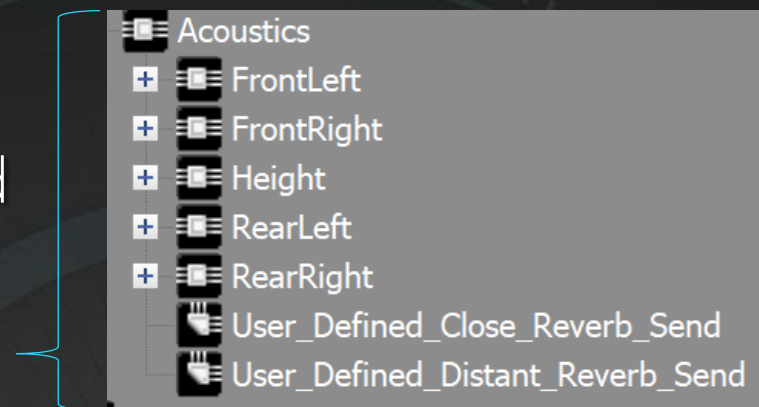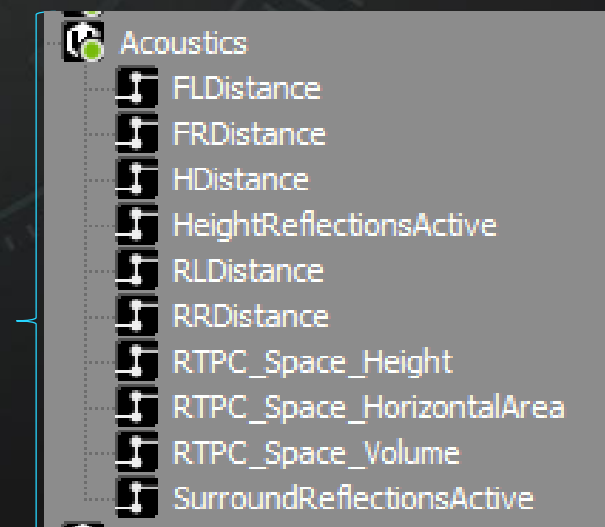
# Acoustics Tuning

- Raycasts
  - Listener-relative (camera)
  - Jittered
    - 4 Rays per direction
    - up a bit, down a bit, left a bit, right a bit
  - Smoothed
    - Lerp between the previously sent value and the latest raycast value
    - we take 2/45ths of the current value and 43/45ths of the previous value each frame
    - Slow enough not to be jarring when you drive past a lamp post and fast enough to not be obviously lagging
  - Measure distance
    - Max 50m due to perf

# Acoustics Tuning

- **RTPCs**

  - **[XDirection]_Distance**
    - Used for attenuation, bandpass over distance

  - **[Endpoint]_Active**
    - Used to mute inactive sends so we don't get fold down issues

  - **Space_Volume**
    - Derived from raycasted distances
    - Rudimentary values up to 1,000,000 cubic M.
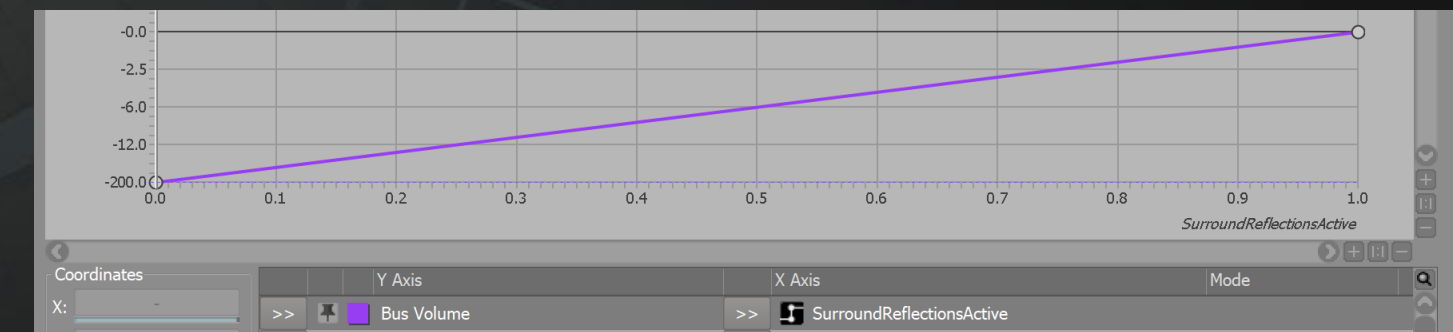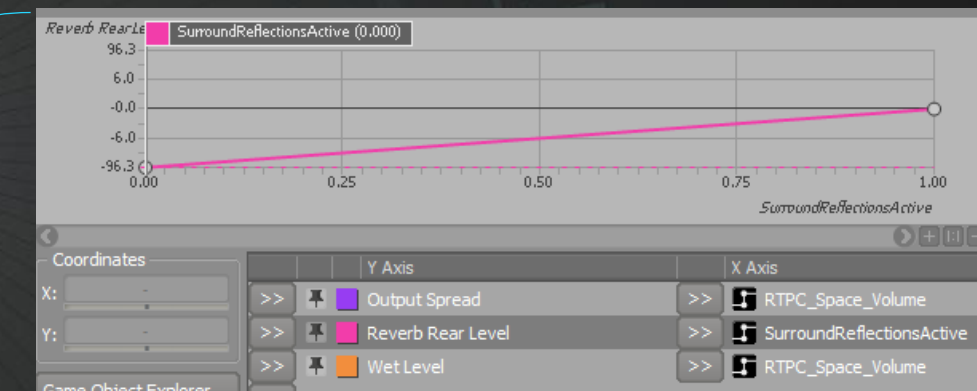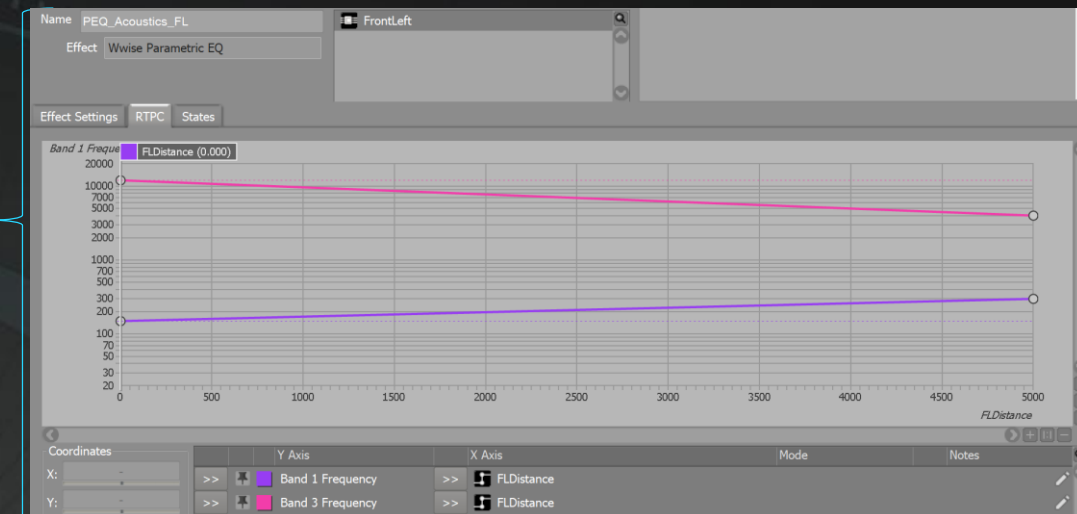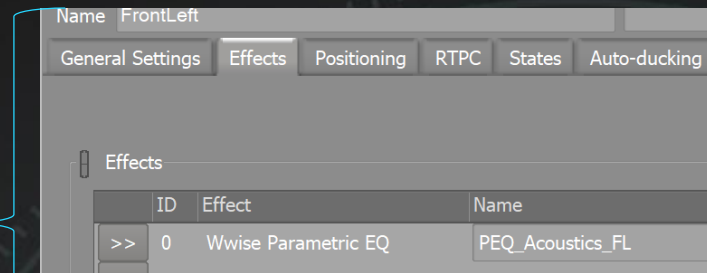
# Acoustics Tuning

- Reverb

  - Key Close + Far Convolution Reverb tuning

    - Spread more based on "Space Volume"

    - Crossfade reverbs based on space volume

    - Disable reflections not active for current endpoint

# No Acoustics

Nimbus Game Preview Standalone (64-bit/PCD3D_SM5)

BLUEPRINT COMPILE ERROR

CON

50

NIMBUS (Development Editor) BUILD (CL: 292059) //Nimbus_Streamed/Campaign_Light_WithLocalisation
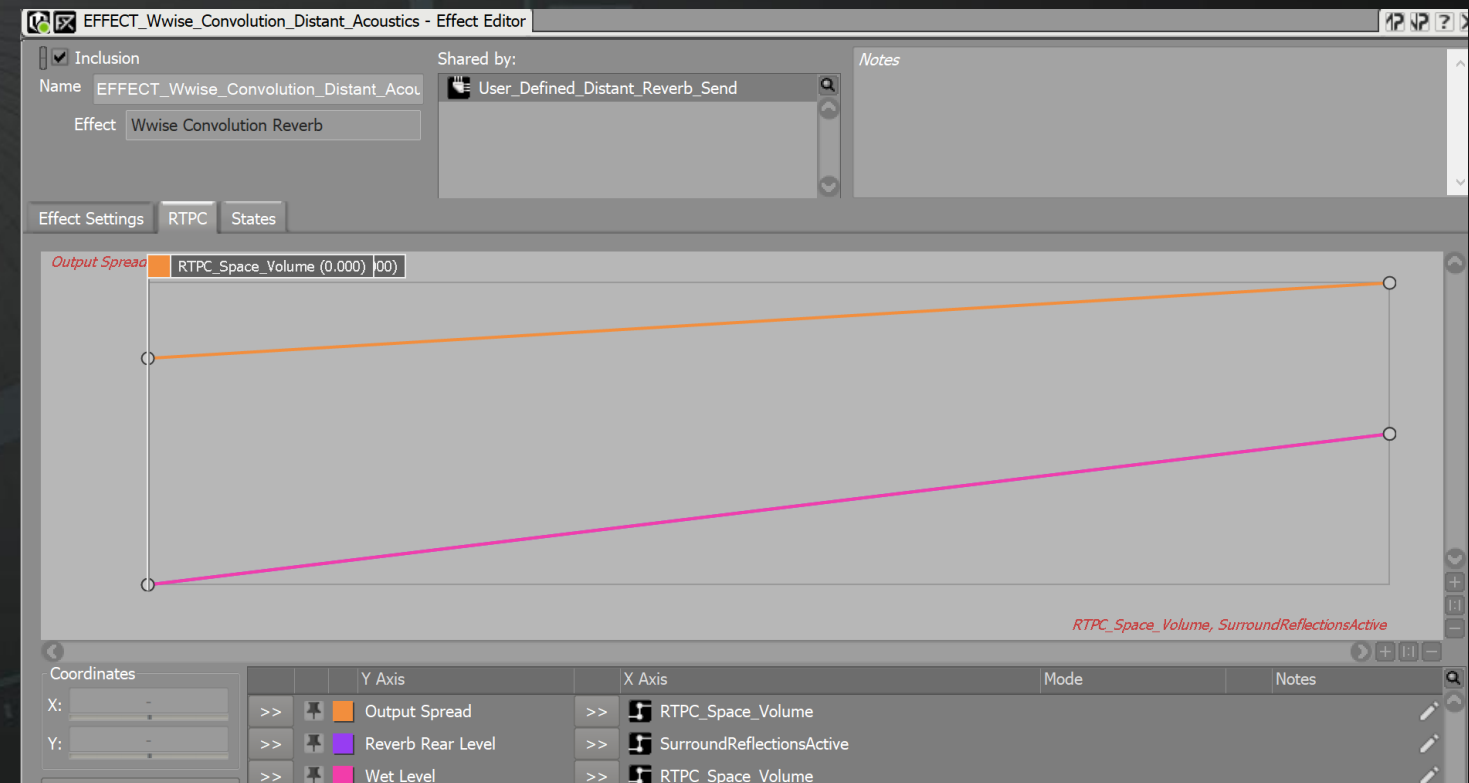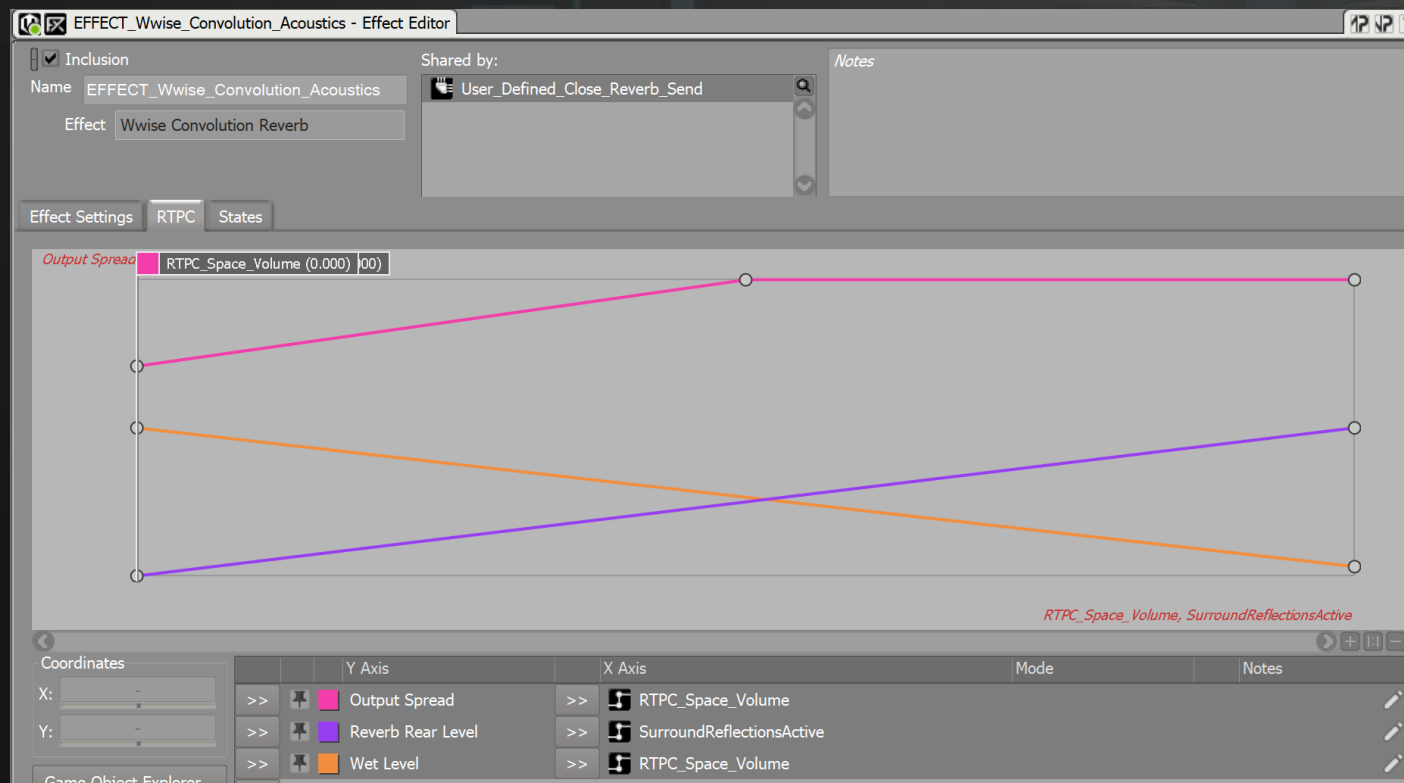
# Distant Reverb Only

Acoustics Only

# Full Acoustics

# Acoustics on voices

# Acoustics on voices

# Acoustics on Propaganda

# In Four Parts
## Cloud Destruction
## Physics Audio

Crackdown 3: Wrecking Zone's Destruction Audio

00:00

0%

4
/4
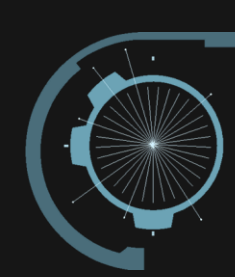
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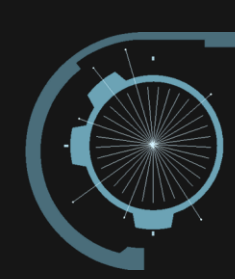
PART ONE
Destruction Physics Definitions

Crackdown 3: Wrecking Zone's Destruction Physics
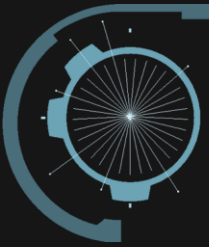
# Challenges – How do you make audio sense of this?

- Architecture
  - Cloud Server→ Local Server→ Local Client→CPU or GPU
  - Physics & Actors → CSP → Render (audio/visual)
  - VFX actors → Client→ GPU → Render
- Behaviors
  - Moving, spinning, sliding, damaging, breaking, deleting/cleanup
- Scale
  - 1-10,000's of objects updating across network(s)
    - State / position / orientation
  - Huge range for object size
    - 50kg to 1000000kg

## Key Terms

- ### Physics Chunks
  - Havok bodies with a full range of physics behaviors processed on the server.
- ### GPU Chunks
  - Particle effects of smaller objects.
  - Created and processed on the Client *but only on the GPU.*
  - Constrained to Impact and DeRez for a limited set of materials *while on screen.*
- ### Static Geometry
  - Collide-able but non damage-able or destroyable geometry (the ground)
- ### Impact
  - The collision of destruction objects with each other or static geometry.
- ### Destroy
  - The separation of a havok body into 2 or more child objects.
- ### Impulse
  - The intensity of a collision based on the masses and relative speed of the colliding objects.

CRACKDOWN 3

- Nested Switches
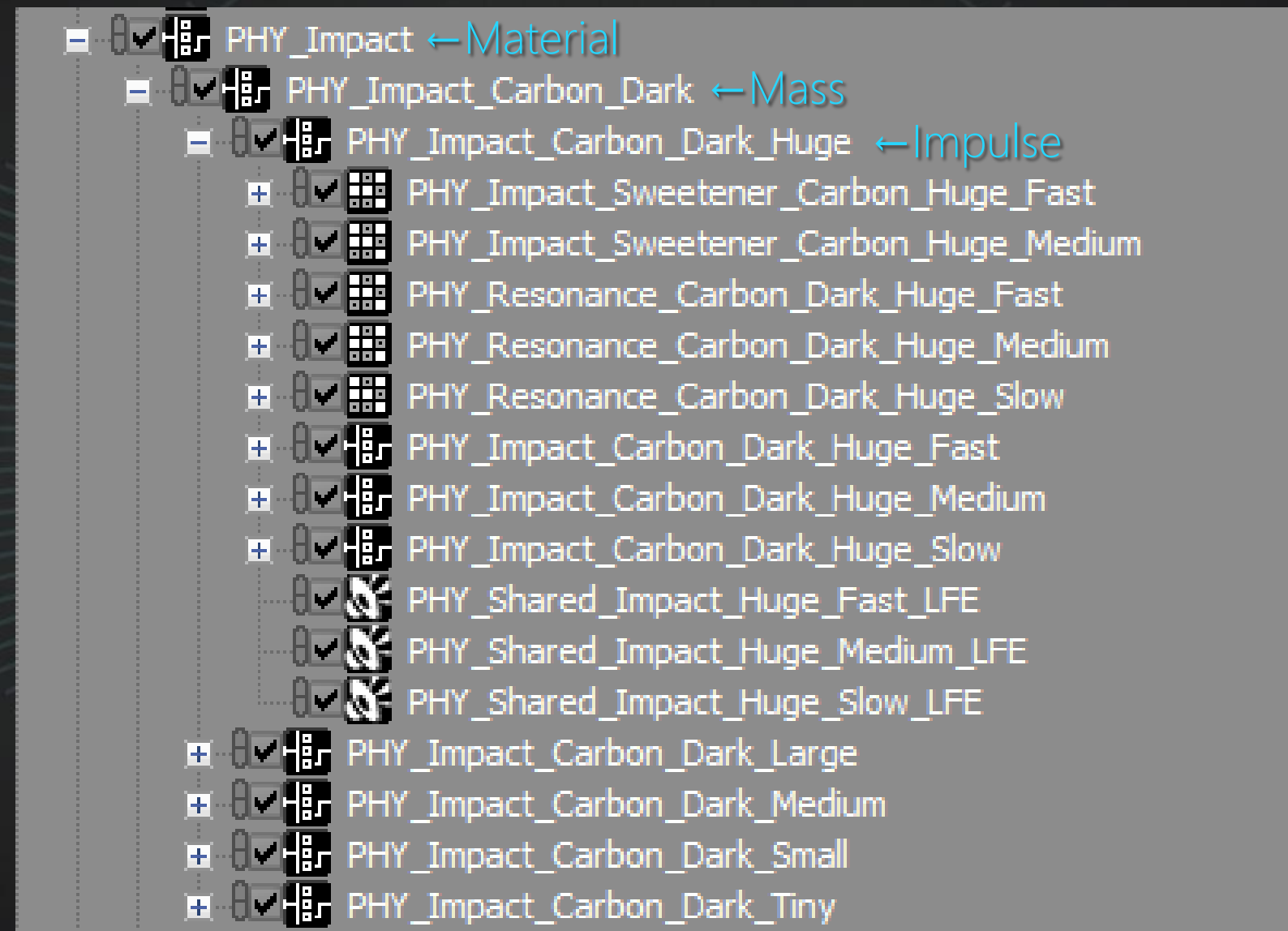
- Material
  - **Concrete** - Thick, vertical cladding on all buildings.
  - **Carbon Dark** – Thinner floor and ceiling material on all buildings.
  - **Metal** – A variety of metal support structures and panels that make up elevated walkways.
  - **Steel** – Beams and girders that make up the superstructure for buildings.
  - **Glass** – Windows and glass panels.  (GPU Objects only)

CRACKDOWN
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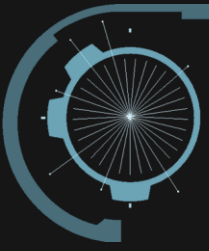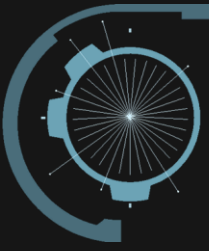
# Mass

- ## Each material has a unique set of mass thresholds
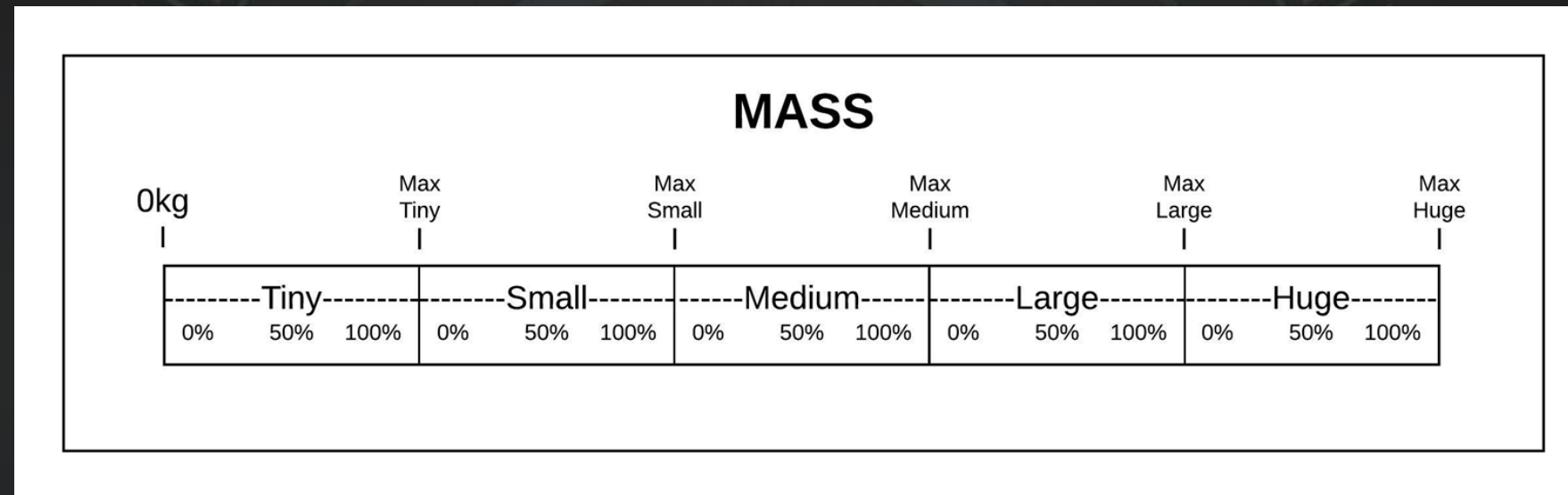


- PHY Impact Mass Percent RTPC = tracks the mass of each object as a percentage of the range of its particular mass category.

# Impulse

- Each material also has a unique set of Impulse thresholds per mass category that determine the intensity of each collision.
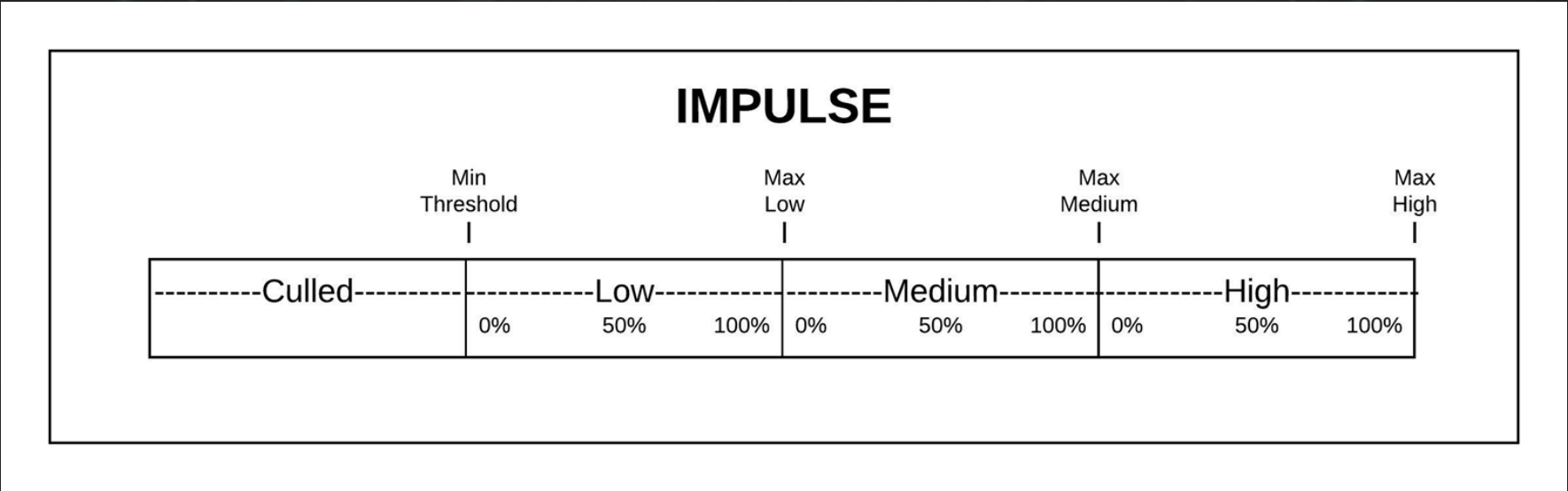


- An RTPC called PHY Impact Impulse Percent tracks the impulse value of each object as a percentage of its Impulse range.
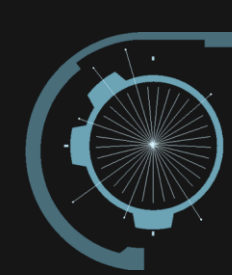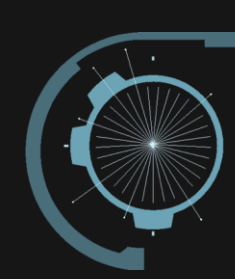
# PART TWO
## Destruction Physics Behaviors

- Destruction physics system behaviors:
  - Damage (Ballistic)
  - Destroyed
  - Turbulence
  - Impact
  - Scrape
  - De-Rez

- Damage Ballistic
  - Ballistic Impacts by projectile weapons
  - Does not apply to prop based projectiles (rockets, grenades, etc)
    - GPU Chunks generated at the point of impact.

- Destroyed
  - Havok bodies fracturing into two or more smaller objects
  - Content for material
    - Carbon Dark, Concrete, Metal, Steel, Glass
  - Content for size
    - Small, Medium, Large, Huge, Enormous

CRACKDOWN
3

- Turbulence
  - Havok Bodies moving through the air.
  - Content sets for each material and size
  - **More details later...**

- Impact
  - IF [Physics Chunk] is [Collides] with [Physics Chunk] or [Static Geometry]
    - "Two hands clapping"
      - Exception: Impacts are disabled on static geometry
  - Multiple layers for each material/size set
    - Impact, Resonance, Sweetener and LFE layers
    - Concrete and Carbon Dark impacts further divided into Single and Merged impacts. (More on that later…)

CRACKDOWN 3
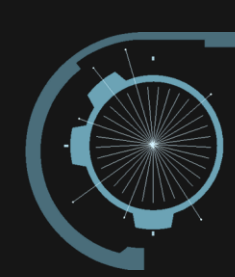
- Scrape
  - IF [Physics Chunks] are [in motion] AND contacting [Physics Chunk] or [Static Geometry] then [=scraping]
  - Content sets for each material and size
  - Multiple layers for each material/size set
    - Scrape Loops (Fast/Medium/Slow), Scrape Resonance and LFE layers

# Let us hear it!!

- Destruction audio only

# Let us hear it!!

- All together now! Our little miracle. <3

# DeRez for cleanup

- "Combat Simulator" dematerializing objects
- This system doubles as object cleanup
- Content sets for each size, but not each material

# PART THREE

## Building Destruction

CRACKDOWN 3

# Building Component Definitions

## Buildings

- A building is a prefab collection of destruction materials attached to a superstructure of steel beams
- What the player perceives as a building in the game is often made up of multiple "buildings"

## Attachments

- Walkways that connect buildings to other buildings or static geometry

# Building Damage States

- Buildings enter various damage states depending on their health compared to thresholds set for each building.

  - Damaged

  - Critical

  - Pre-Collapse

  - Collapse

  - Destroyed

- ## PHY Building Damaged
  - Building weakened by damage
    - Soft metal creaks and groans on a randomized delay
  - Creak emitters on superstructure joints
    - Superstructure joints are merged within a 5m radius
  - Attenuations and Azimuth used to help with directionality and overall mix.

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- # PHY Building Critical
  - Greatly weakened by major damage but not enough to collapse
  - More frequent and severe creaks and groans
  - Uses the same merged superstructure joints as PHY Building Damaged

- # PHY Building Pre-Collapse
  - Pre-Collapse one shot signals that the building is now Queued for Collapse
    - Design element emitting from the center point of the building
    - Wide attenuations to telegraph to all nearby players
  - Pre-collapse loops support the story of an unstable building about to collapse
    - Rumble and LFE loops emitting from the base of the building.
    - Narrower attenuations

- ## PHY Building Collapse

  - Superstructure collapses and the building comes down

  - Collapse one shot signals that the building is now Collapsing

    - Design element and additional LFE sweetener emitting from the center point of the building

    - Wide attenuations to telegraph to all nearby players

  - Collapse loops create the rumble of the building collapsing

    - Rumble and LFE loops emitting from the base of the building.

    - Narrower attenuations

# Building Destruction Only
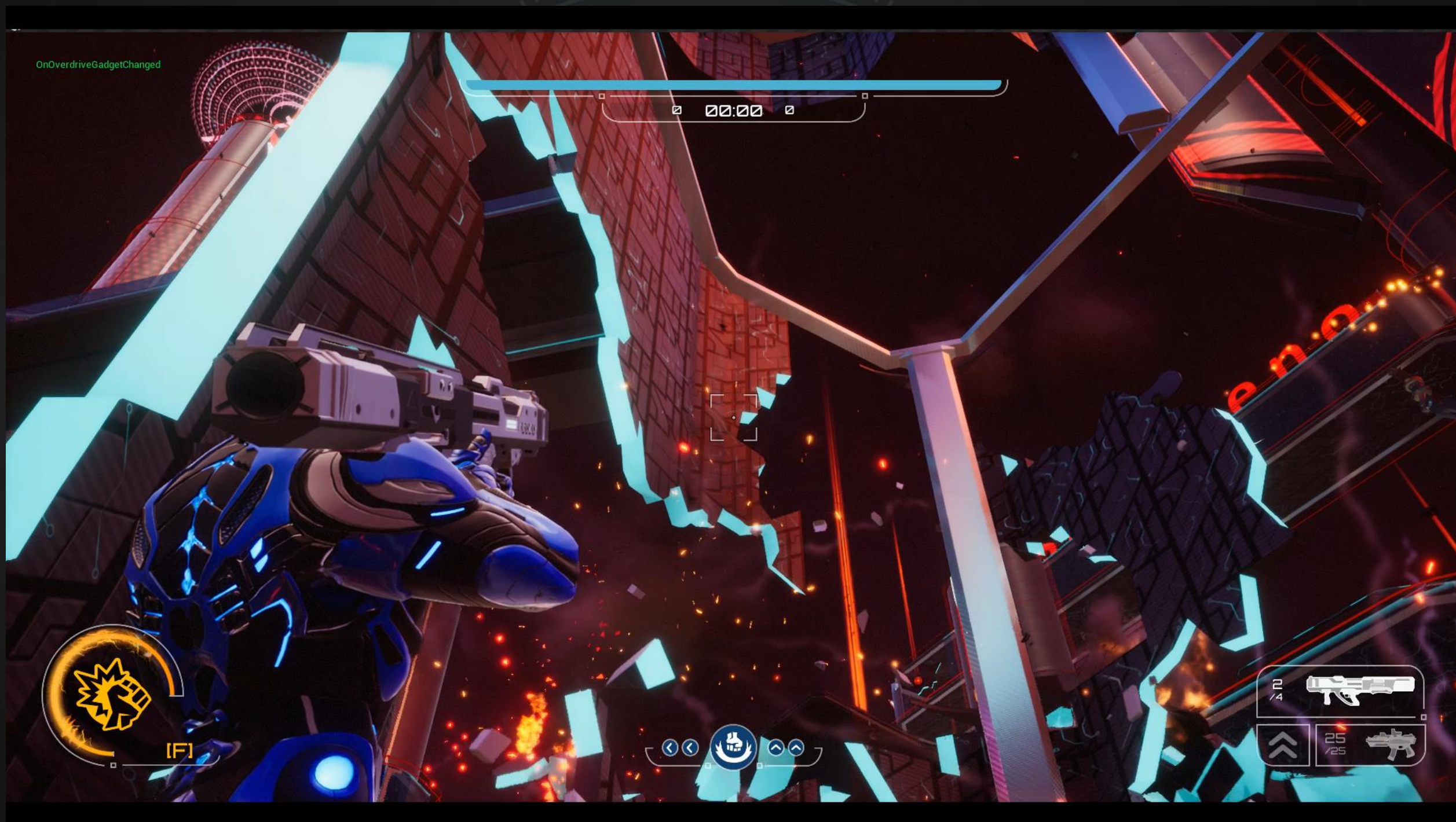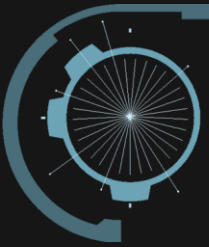
PART FOUR

Performance Tuning

- Destruction is processed on the server
  - Exceptions are GPU "chunks"
    - glass, "tiny" sized concrete, and "carbon dark"

- Relevant events sent to each client
  - At peak, a 10 player match can generate 10,000+ collisions per frame on the server
  - The number of messages sent to the client needs to be limited for network traffic purpose as well as wwise optimizations and mixing

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SERVER

Please note that this displays the full flow chart for Concrete Huge. Assume any Grey boxes branch and flow in an identical fashion

COLLISION MERGING

# Destruction Voice Priorities

| Destroy | Huge | Large | Med | Small | Tiny |
|---|---|---|---|---|---|
| Metal, Steel | 55 | 50 | 45 | 40 | --- |
| Concrete | 45 | 35 | 30 | 25 | --- |
| Carbon_Dark | 45 | 35 | 30 | 25 | --- |
| Glass | --- | 45 | 40 | 35 | --- |
| **Impact** | **Huge** | **Large** | **Med** | **Small** | **Tiny** |
| Metal, Steel | 65 | 60 | 50 | 40 | --- |
| Concrete | 60 | 55 | 50 | 30 | 20 |
| Carbon | 60 | 55 | 45 | 25 | 20 |
| Glass | --- | 40 | 35 | 30 | 25 |
| **Turbulence** | **Huge** | **Large** | **Med** | **Small** | **Tiny** |
| Concrete | 50 | 45 | 40 | 35 | --- |
| Carbon_Dark | 50 | 45 | 40 | 35 | --- |
| Metal, Steel | 50 | 45 | 40 | 35 | --- |
| **Scrape** | **Huge** | **Large** | **Med** | **Small** | **Tiny** |
| Concrete | 35 | 30 | 25 | 20 | --- |
| Metal | 35 | 30 | 25 | 20 | --- |
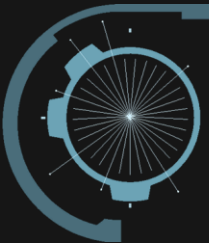
# PHY Destroyed Optimizations

| Fracturing | |
|---|---|
| Global Max New Fractures | 2 |
| Global Destroy Importance Distance Weighting | 1.0 |
| Global Destroy Importance Mass Weighting | 1.0 |
| Per Parent Object Destroy Importance Distance Weighting | 1.0 |
| Per Parent Object Destroy Importance Mass Weighting | 1.0 |
| Per Parent Object Max New Fractures | 1 |

# PHY Scrape Optimizations

# PHY DeRez Optimizations

| DeRez | |
|---|---|
| Max De Rez Events Per Frame | 30 |
| Max De Rez Distance | 6000.0 |
| Min De Rez Mass | 0.001 |
| Max De Rez Mass | 15000.0 |
| De Rez Importance Distance Weighting | 0.7 |
| De Rez Importance Mass Weighting | 1.0 |
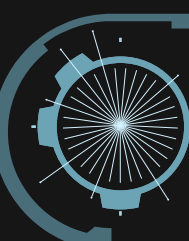
# Cloud Destruction
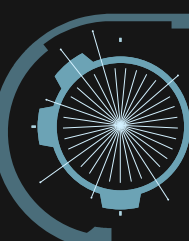
# Turbulence Deep Dive

- If an object is moving through the air, it creates turbulence! (That's what a whoosh is.)

- Project demands it: lots-o-physics flying around

- Simple conditions:
    - If [in motion] and [not colliding] Play_OBJ_Turbulence
    - If [colliding] or [not moving] Stop_OBJ_Turbulence

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# Turbulence Deep Dive

- Multiple content layers for each object or material+size set
  - Looping sounds
    - Turbulence (SoundSeed Wind)
    - [Object] Resonance
    - [Object] Sweetener
    - LFE
- Parameters
  - Doppler, Azimuth and Elevation used to enhance the pass by
  - Rotational velocity to modulate audio during a spin
  - Speed to control volume and pitch

# Scope = Large

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# Prop Turbulence (solo'd)

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# Destruction Object Turbulence (solo'd)

# Wrecking Zone turbulence

# LFE philosophy

- LFE is awesome!
  - Convey weight and power.
- Light bulb moments
  - "puh" and the "wuh"
  - My home subwoofer sucks
  - Dolby cinema is so impactful
- Subwoofers
  - Speakers with <u>very</u> limited capability
  - Excursion rate, recovery, frequency range, crossover cutoff, etc
- Make it easy for them!
  - <u>Dedicated</u> content only
  - <u>Special</u> content only
  - Limit <u>polyphony and noise</u>
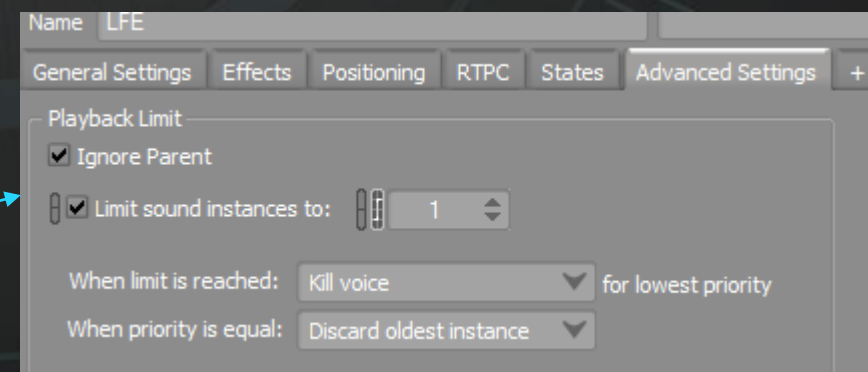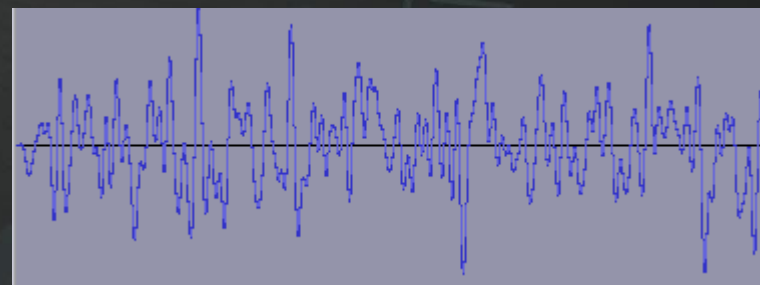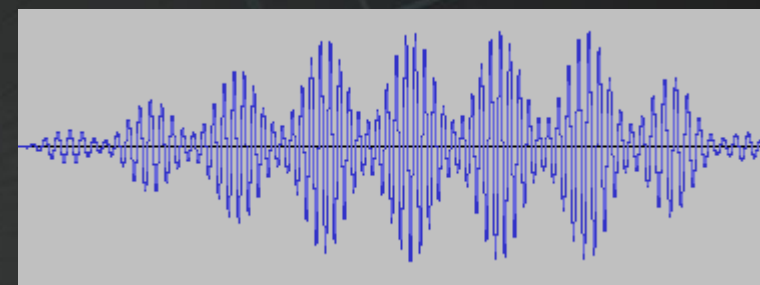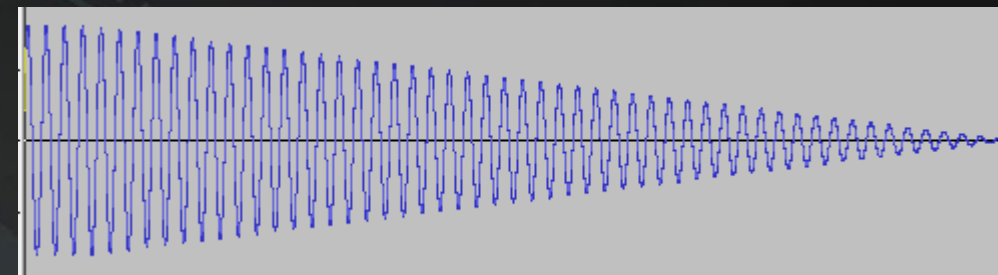
Crackdown 3 Mix

# Mix Goals

- Preserve player feedback
  - Player combat / health
  - Enemies
- Preserve music volume
  - No audible ducking of music
- Resolve frequency contentions
- Maintain audibility of dialog
- Reduce cacophony and noise

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# Mix Tech

- Wwise HDR
- Meters
  - Music, Firearms, Explosives, 2D voice, 3D Boss voice
- Frequency Domain Processing
  - High pass / Low pass / Parametric EQ
- Mix Busses
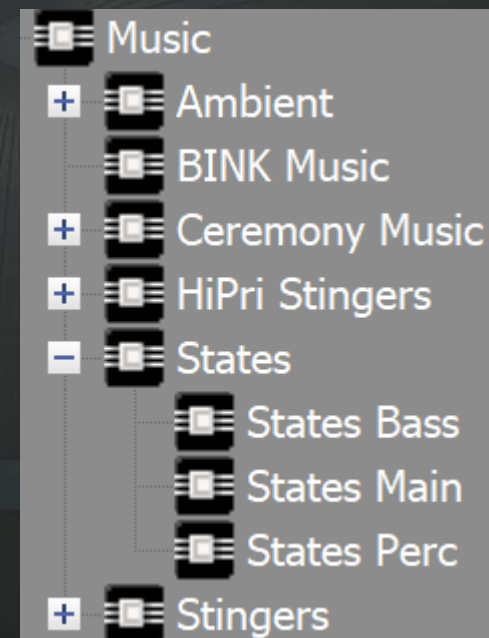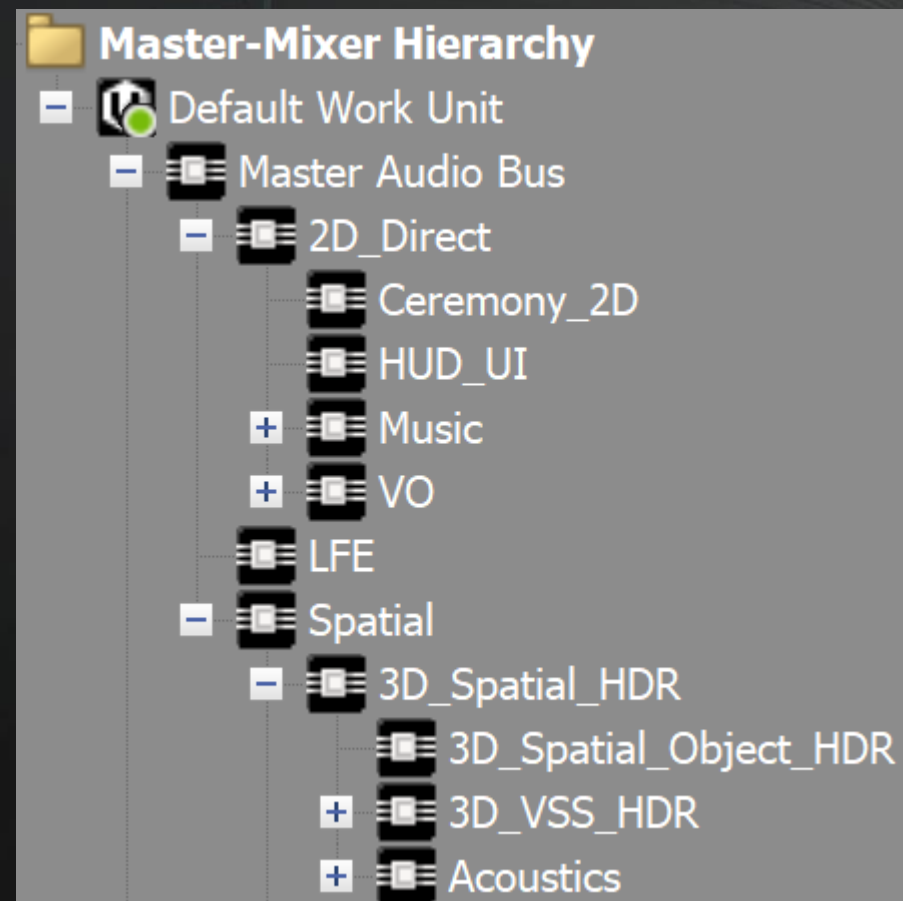
# Mix Tuning

- Wwise HDR
  - Great for sandboxes with chaos
  - Loudest sound "wins" so data integrity is key
- Rules
  - All 3d audio is in HDR
  - All 2d audio is outside of HDR
  - Not-quite a brick wall limiting
  - Threshold of 0, then push things over for HDR
  - Real-ish attenuations for everything
  - Dynamic range
    - 0db baseline
    - +24db topline
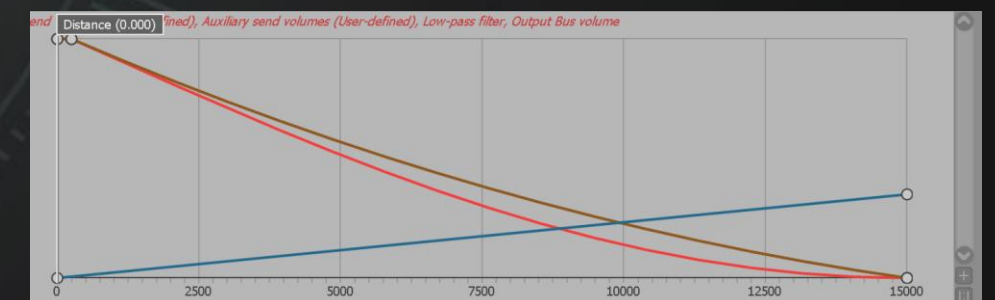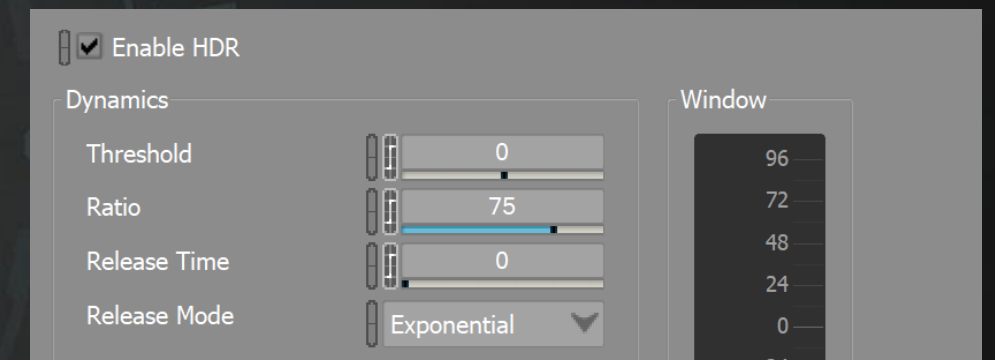
# Mix Tuning

- Meters

  - Peak for SFX, RMS for voice & music, -48 range

  - Fast attack and release on SFX, slower on voice & music
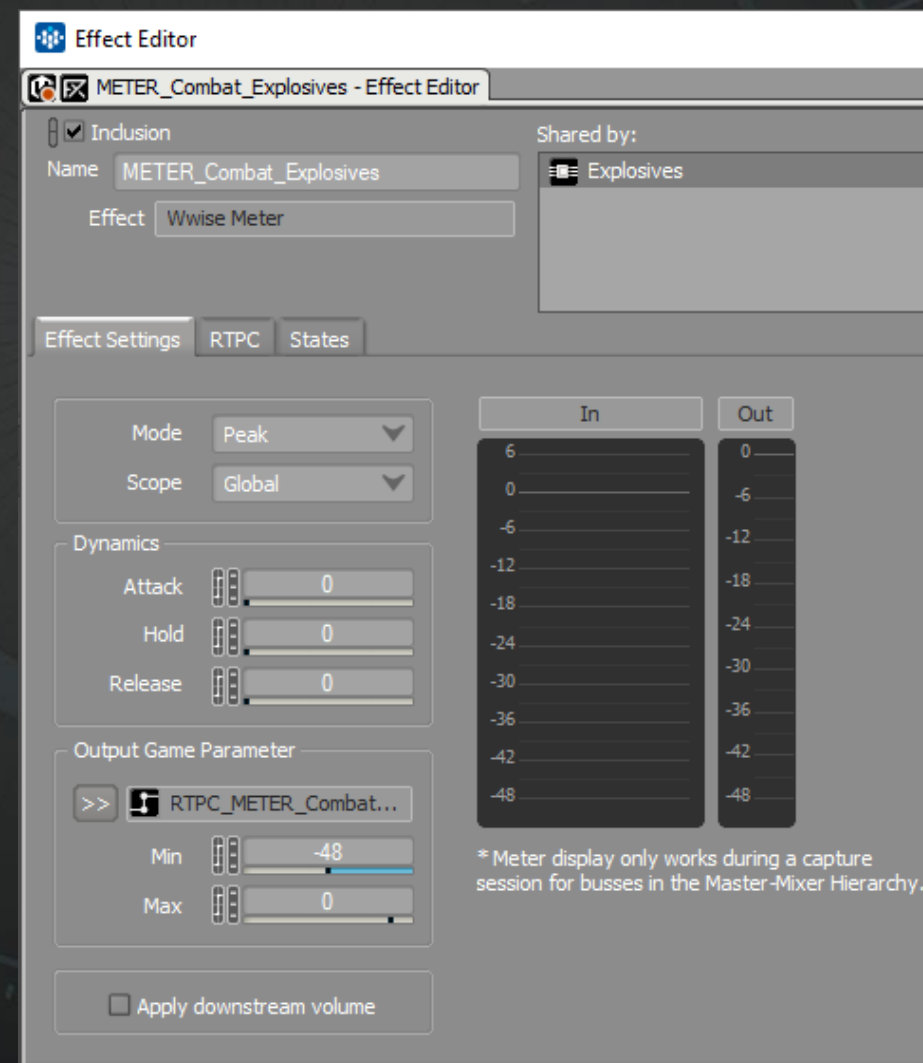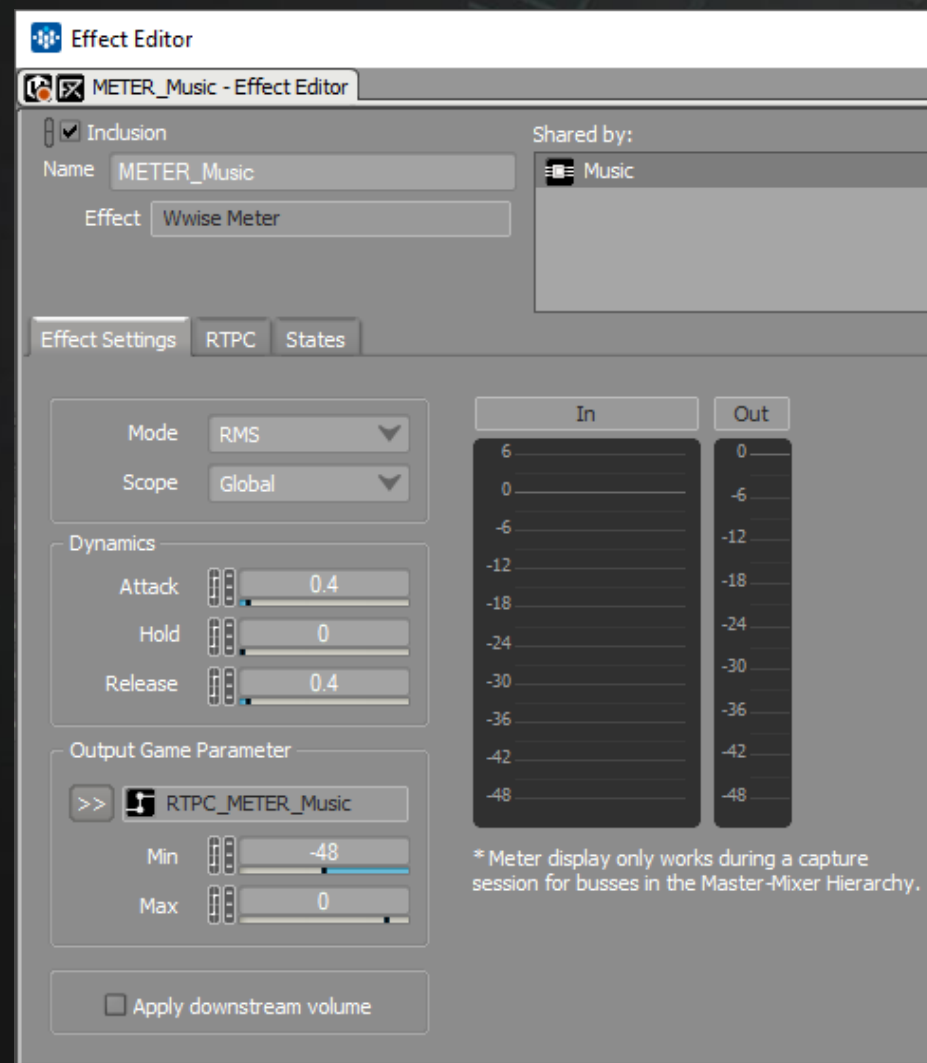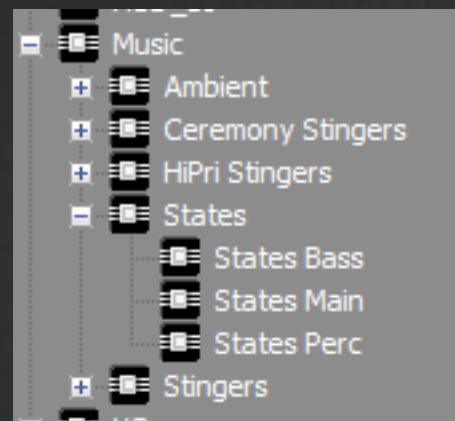
# Mix Tuning

- Frequency contention
  - Voice Meter PEQ's busses
    - (EQ ducking)
    - Intelligibility (2k, 1 octave)
    - Sibilance (3.5k, 1/8th octave)
    - -9db gain
  - Bandpass (high and low)
    - Frequency contention resolution
      - Firearms ➔ LowPass Explosives
      - Explosives ➔ HighPass Firearms
      - Music ➔ HighPass Ambient Loops
      - Explosives ➔ HighPass Music Percussion
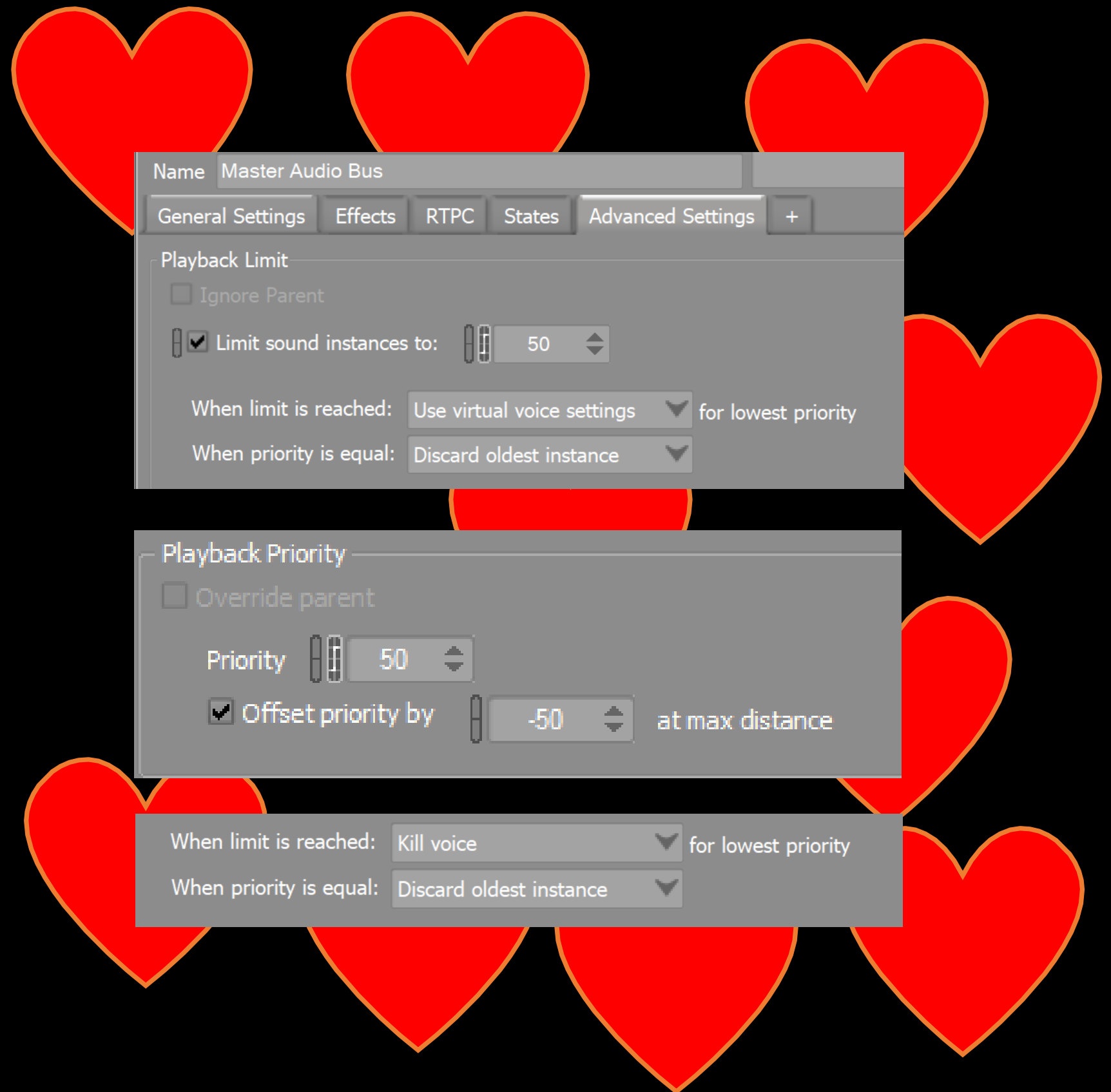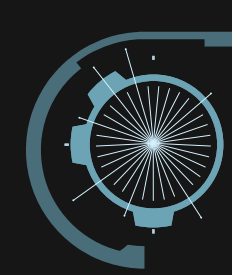      - Firearms ➔ LowPass Music Percussion
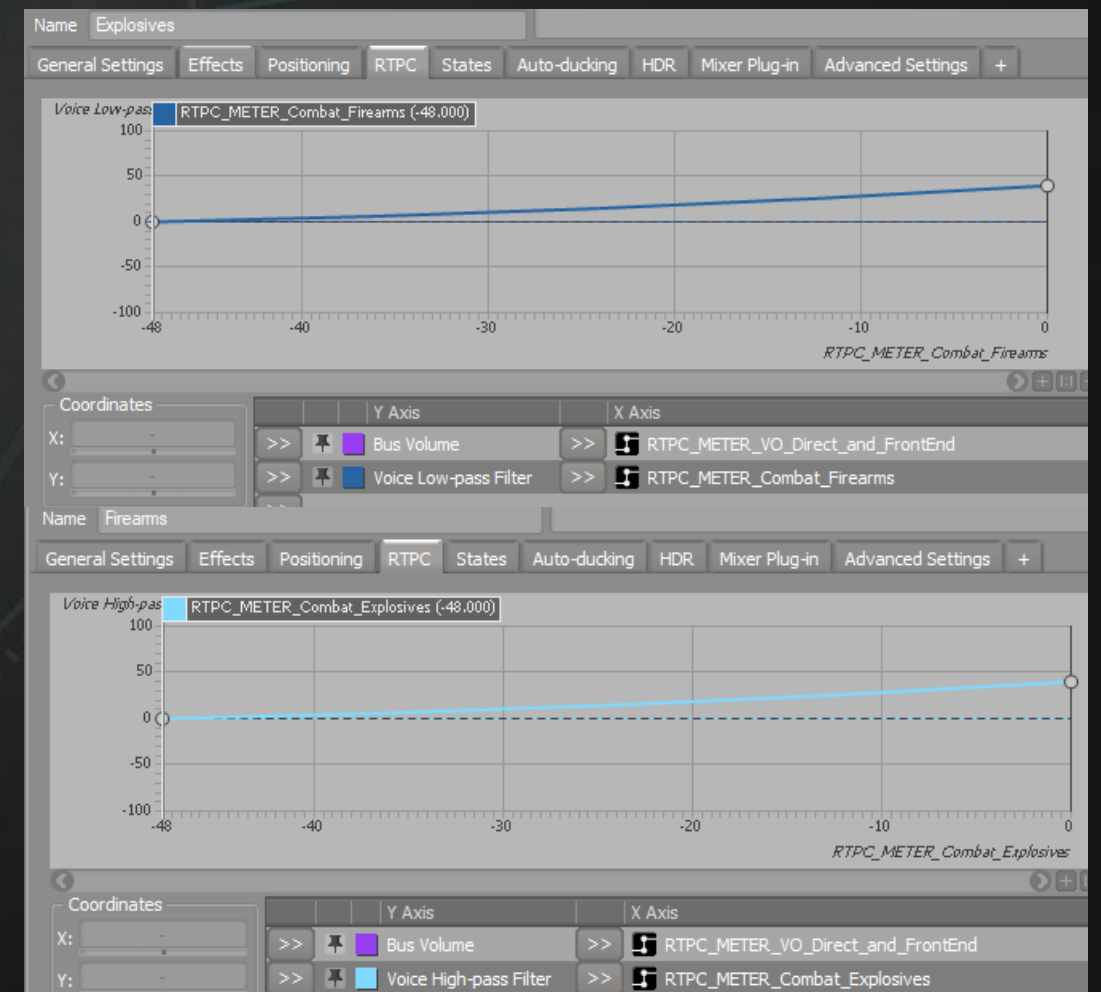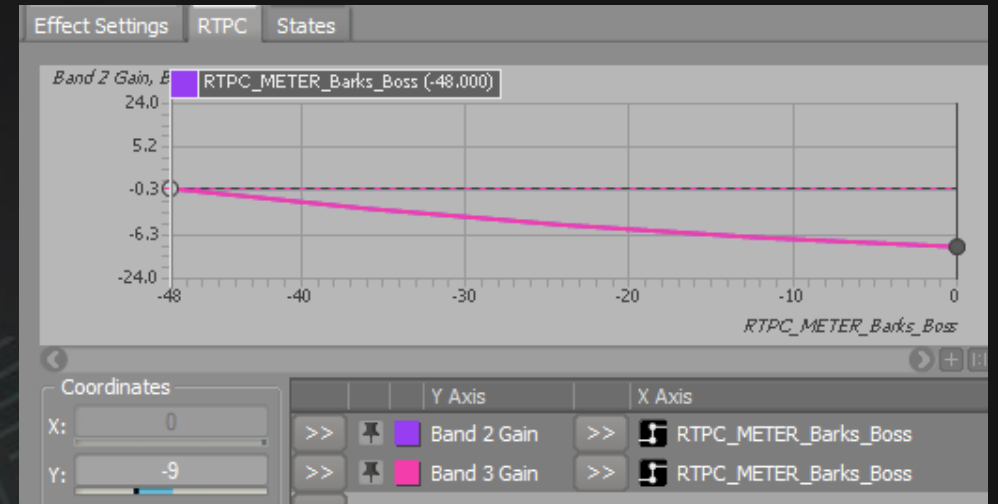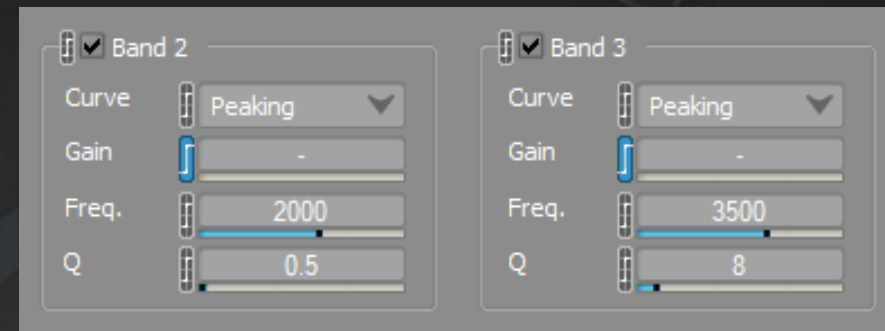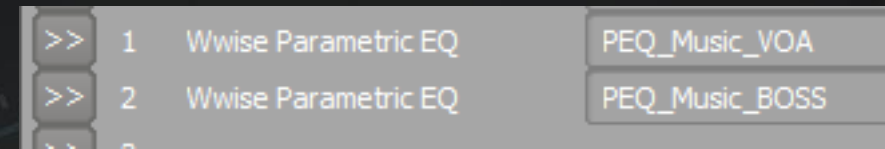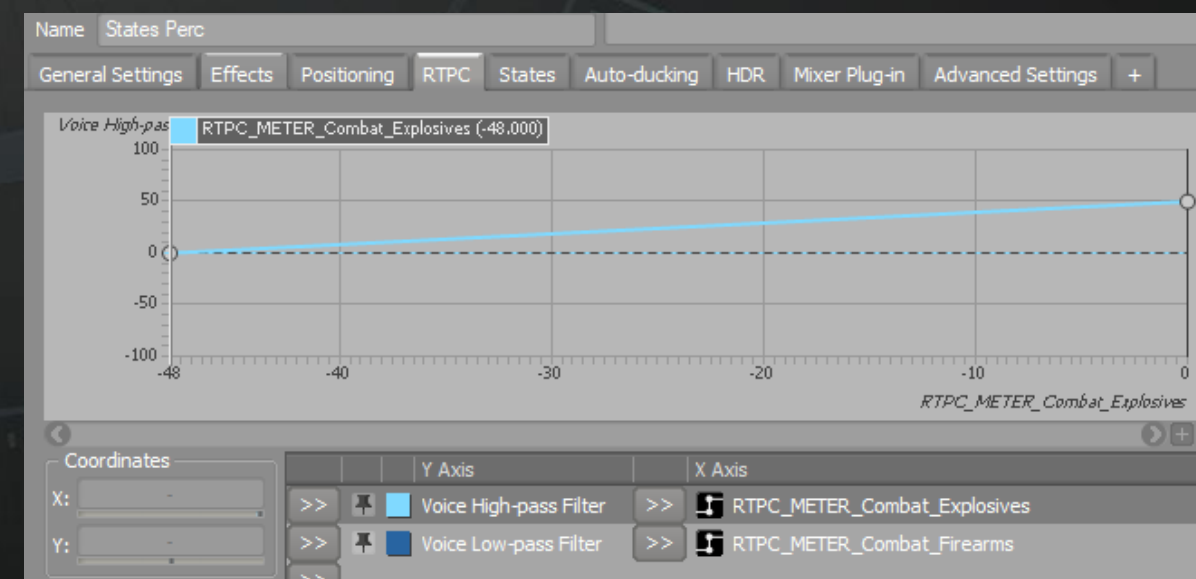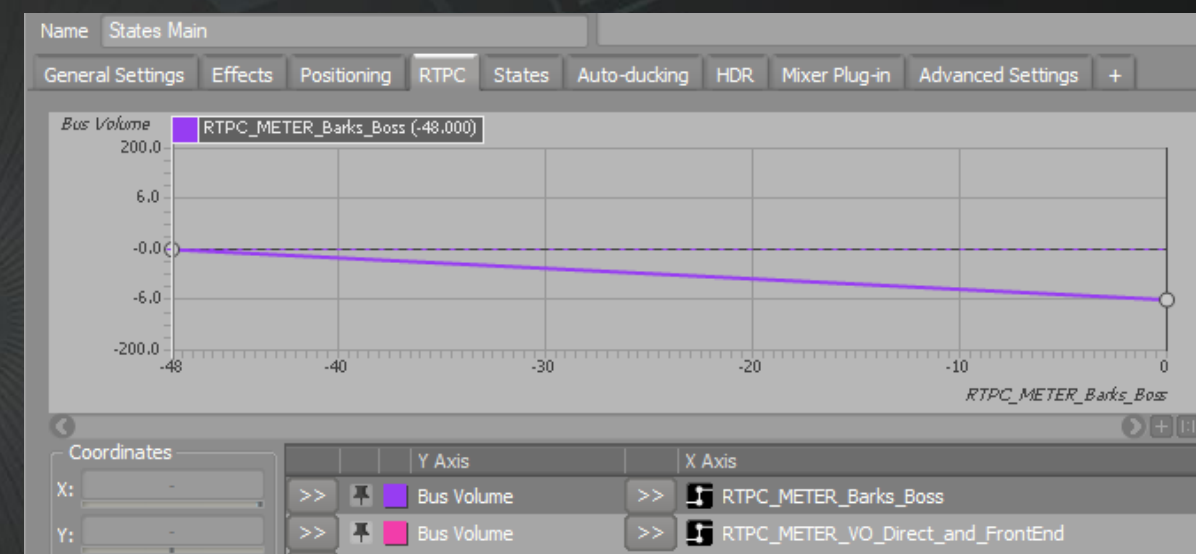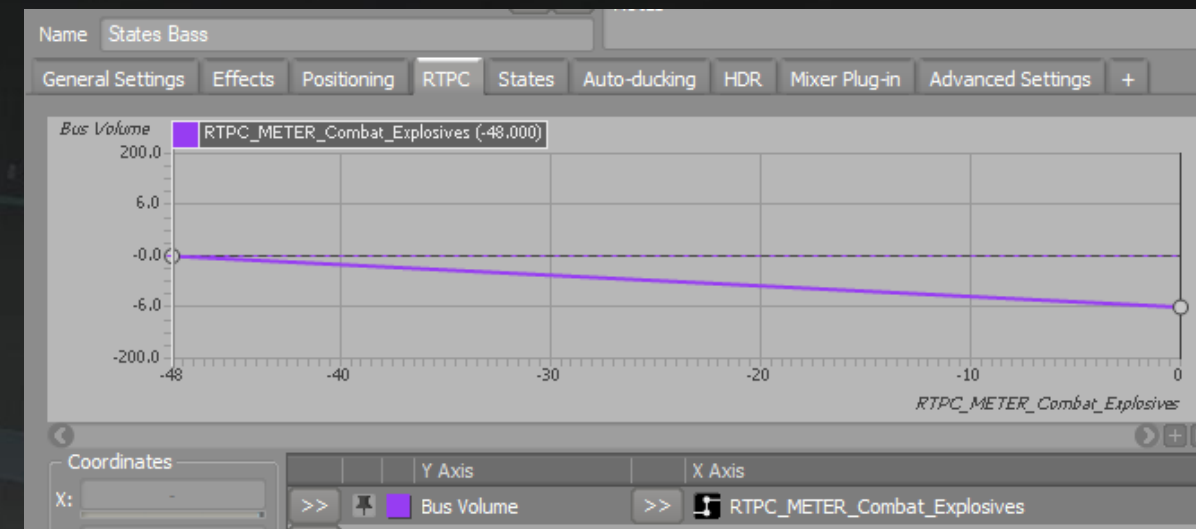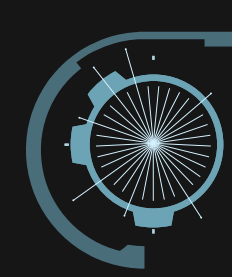
# Managing perf

- No easy fix, sorry!
  - Very few voices allowed (50 max, average 35)
  - Aggressively make voices virtual or kill
    - HDR pushes down volume of less important sounds
    - De-pri to 0 over distance over distance
  - Lots of game object management
    - Limit events, cull events, event merging, etc.
  - Perf issues introduced via wwise data = nonstop auditing and fixing (even post-release, sorry)
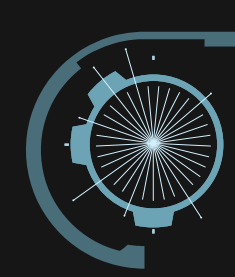
Name  Master Audio Bus

General Settings | Effects | RTPC | States | Advanced Settings | +

Playback Limit
☐ Ignore Parent

☑ Limit sound instances to:  50

When limit is reached:  Use virtual voice settings  for lowest priority
When priority is equal:  Discard oldest instance

Playback Priority
☐ Override parent

Priority  50

☑ Offset priority by  -50  at max distance

When limit is reached:  Kill voice  for lowest priority
When priority is equal:  Discard oldest instance

# Thank you to the Nimbus audio team

Questions? Comments? Heckling!