Watch Dogs 2 - PC Adaptation Success Story with NVIDIA

Jaakko Haapasalo, Producer, GeForce Titles (NVIDIA)
Marius Tudorache, Eastern European PC Director (Ubisoft)
Farid Rzaev, Developer Technology Engineer (NVIDIA)
Oleh Kuznetsov, Senior Programmer (Ubisoft)

November 2016…

The Watch Dogs 2 PC port is great

[...] it runs well, has a ton of graphical options, and comes with a complete set of quality-of-life adjustments for mouse and keyboard players.

PC GAMER

*[T]here is a wide range of options that will allow you to cater the experience to your style, which is **just what a PC port should offer.***

DESTRUCTOID
UNFILTERED NEWS, REVIEWS & COMMUNITY

The PC version is superb, and the game is one of the bright spots in this fall's slate of games.

GAME WATCHER

14 out of 14 PC-specific mentions in critic reviews on Metacritic are positive

"Very Positive" - **82%** on Steam

Success

PC Platform

Agenda

Game Ready Quality Program

Partnering with Watch Dogs 2 PC – Through The Numbers

Ubisoft PC Quality, and working with NVIDIA

Technical Case Study: Eliminating Stutter

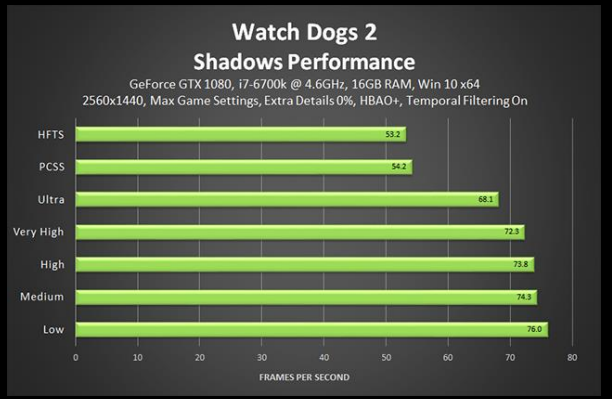
Learnings

Game Ready Quality Program

Jaakko Haapasalo (NVIDIA)

Program Overview

1. PC Technical Requirements Checklist



2. Stability, Performance & Stutter Analysis

3. Minimum & Recommended Specs

(see also)

GEFORCE® EXPERIENCE™

Optimal Performance Settings

Game Ready Drivers

GTM

Title Engagement

1. TRC (Technical Requirements Checklist)

PC platform requirements to validate your game against

Focused on technical quality and readiness, such as resolution support, UI scaling, frame rate, smoothness, settings, and correctness of various effects.

Review involves several play-throughs at different settings, significant investment in QA time

3 review milestones

40 requirements

16 titles tested in 2016 pilot

Requirement Categories

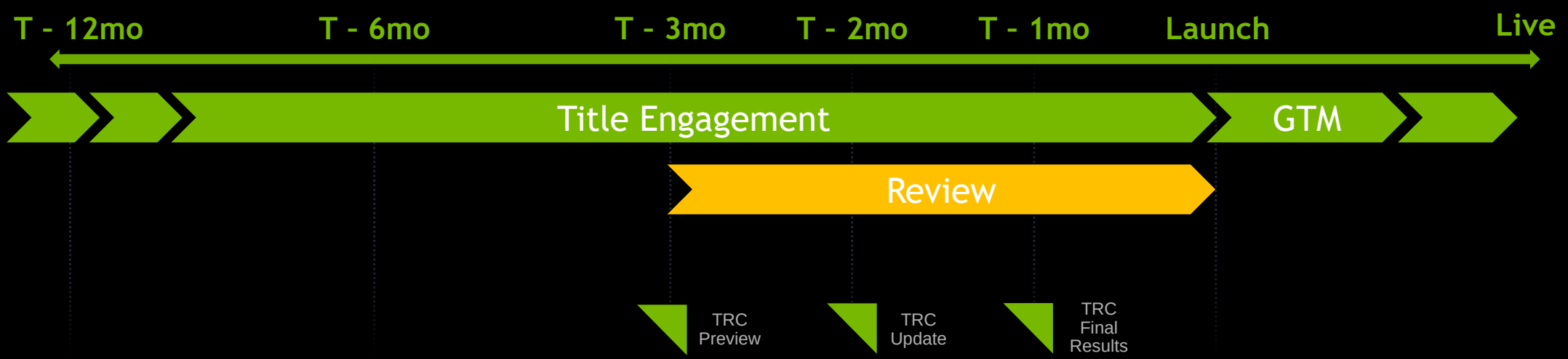
- Required (P0)
  - Core
- Recommended (P1)
  - Quality of Life
- Advised (P2)
  - Forward-looking

Requirements and Rating

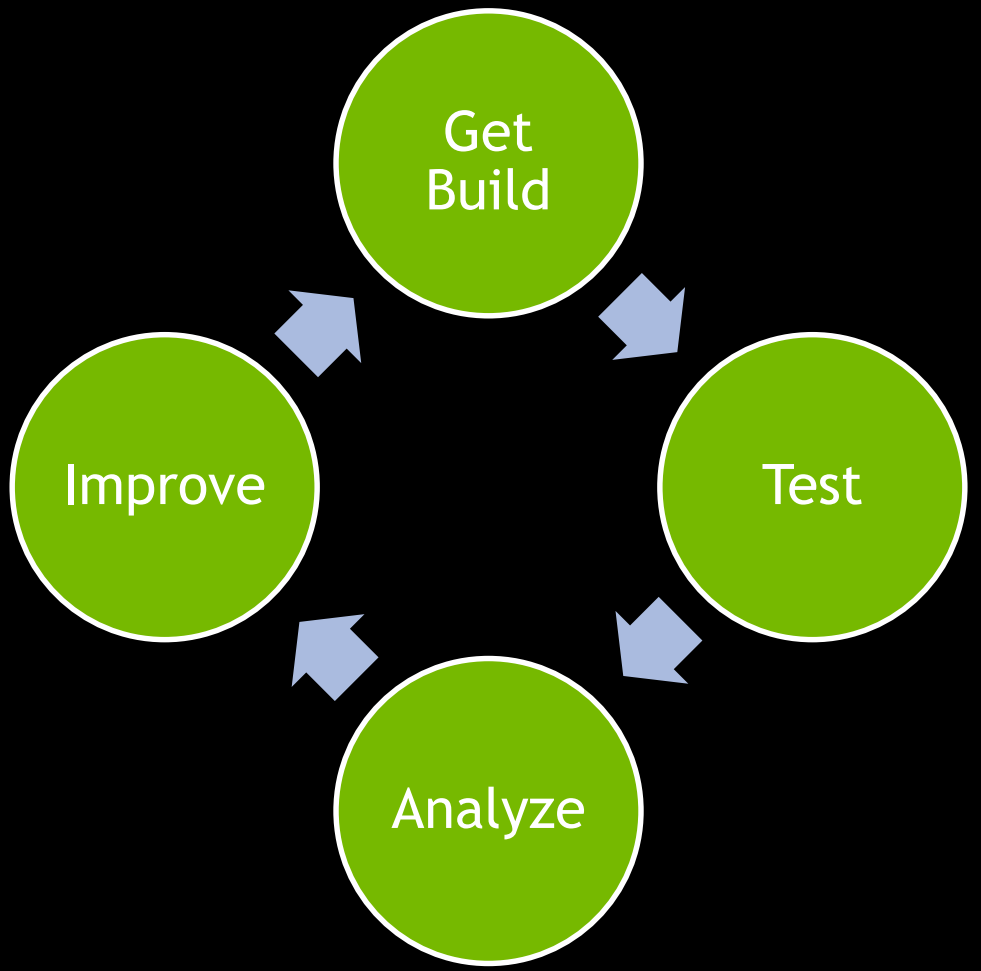
- Description
- Additional information (context, intent and failure modes)
- Criteria for Full, Partial and Failed compliance

- Overall TRC rating as a weighted average (0..100)

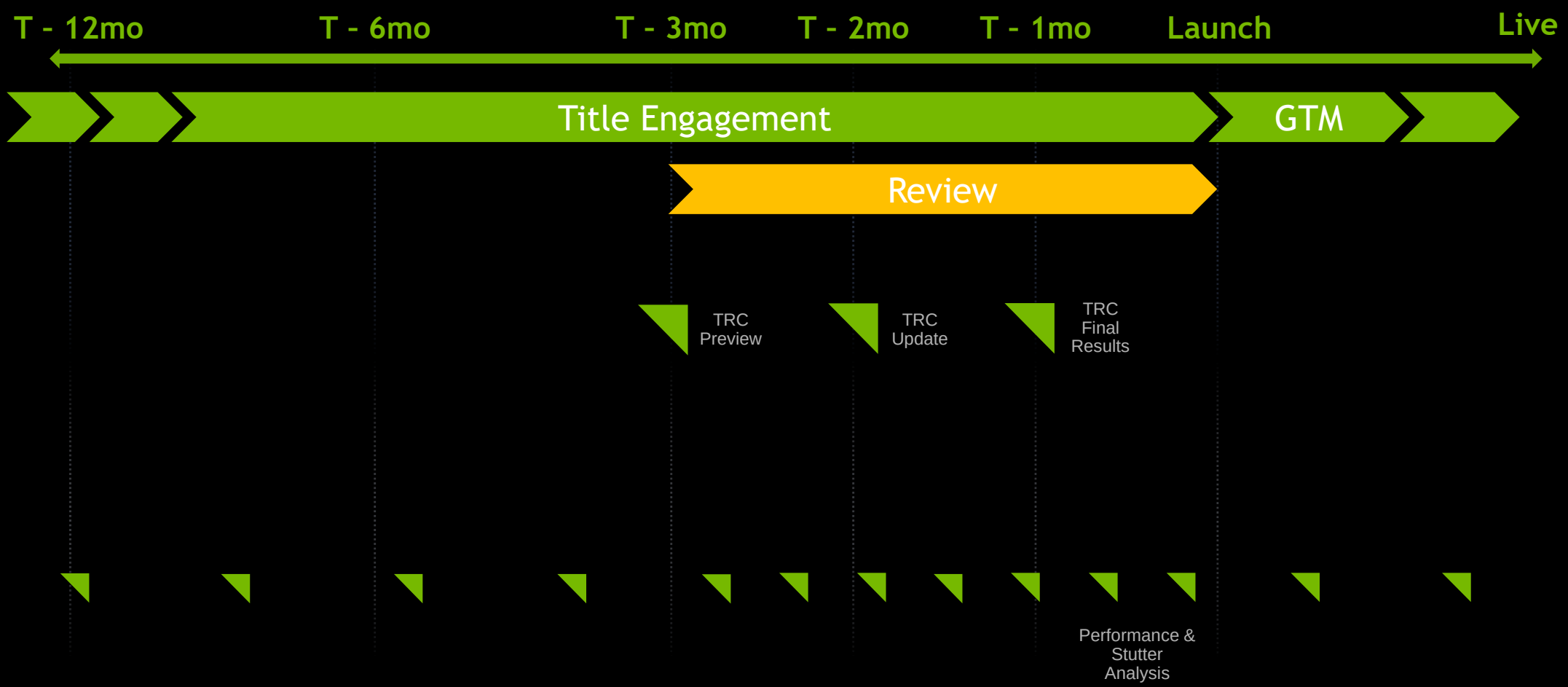
Timeline


T - 12mo
T - 6mo
T - 3mo
T - 2mo
T - 1mo
Launch
Live
Title Engagement
GTM
Review
TRC Preview
TRC Update
TRC Final Results

2. Stability, Performance and Stutter



Timeline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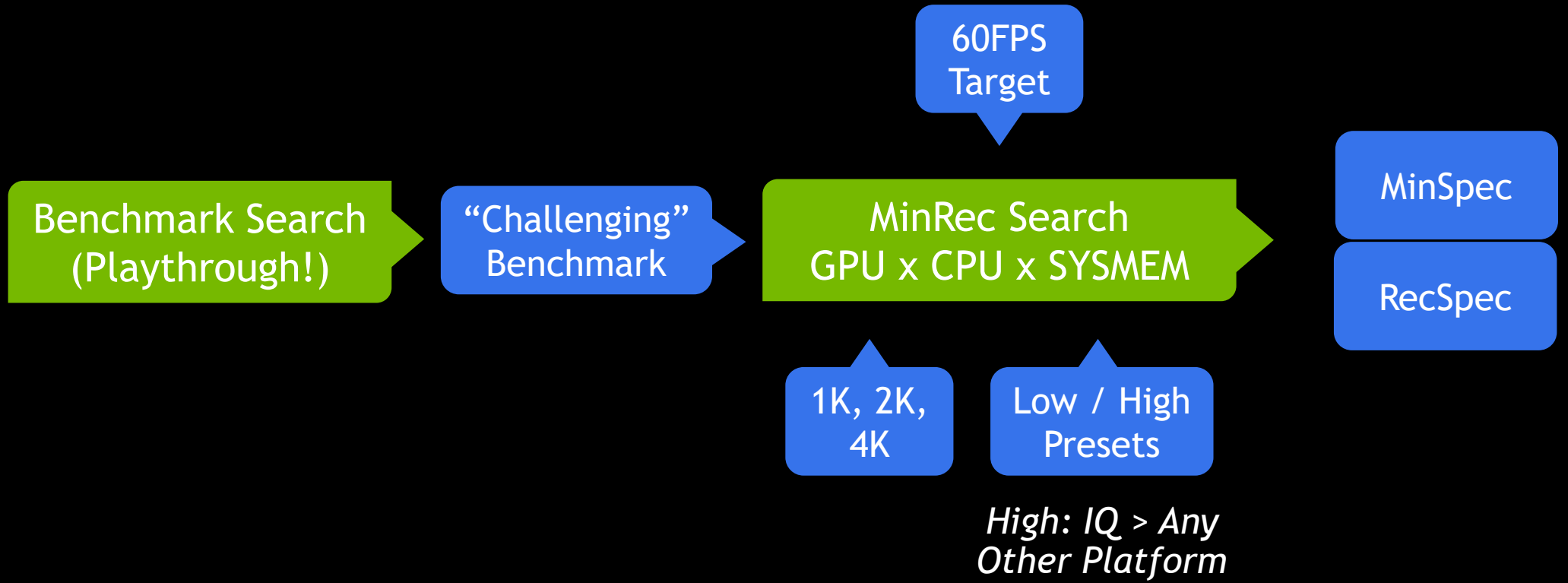
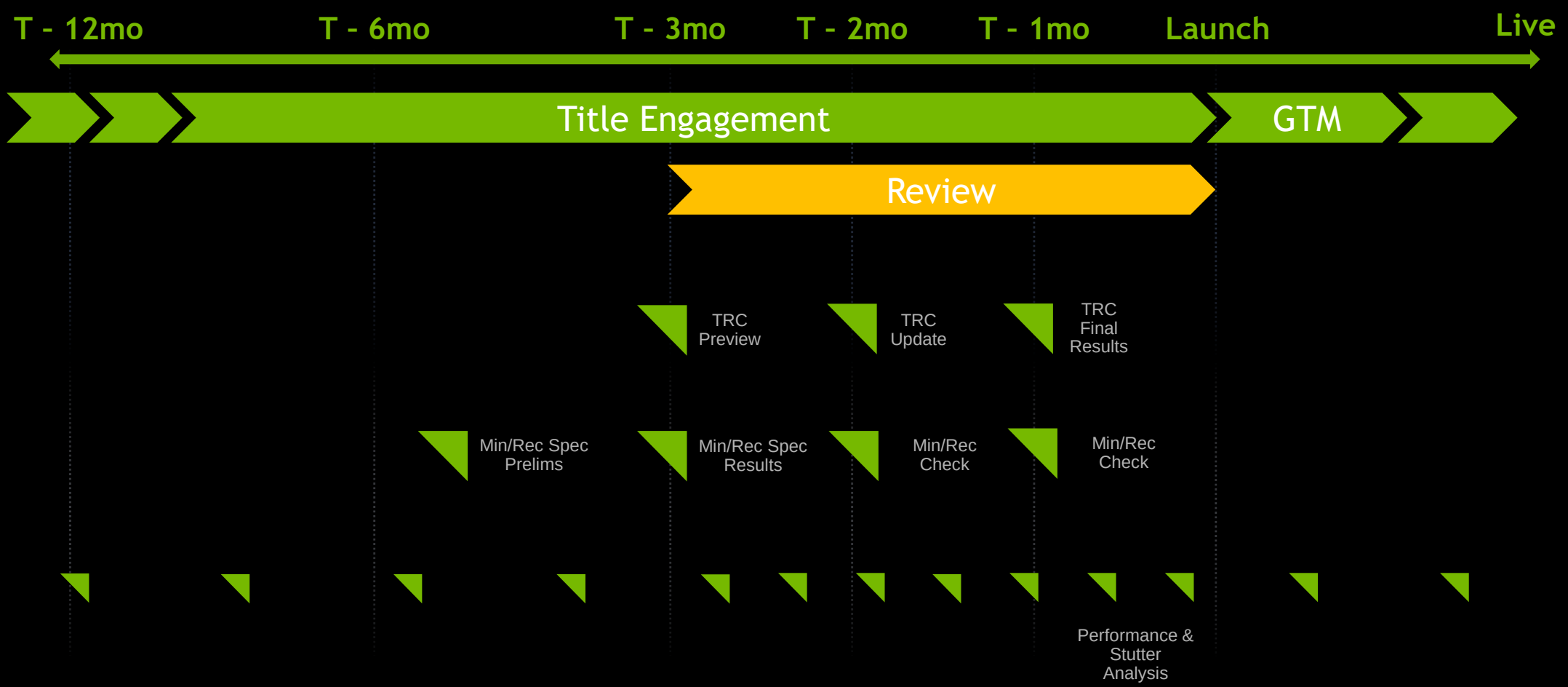
Performance & Stutter Analysis

3. Minimum & Recommended Specs



Timeline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TRC Preview
TRC Update
TRC Final Results
Min/Rec Spec Prelims
Min/Rec Spec Results
Min/Rec Check
Min/Rec Check
Performance & Stutter Analysis

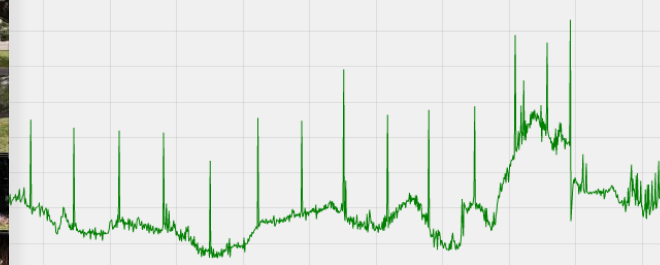
WD2 Game Ready: The Numbers

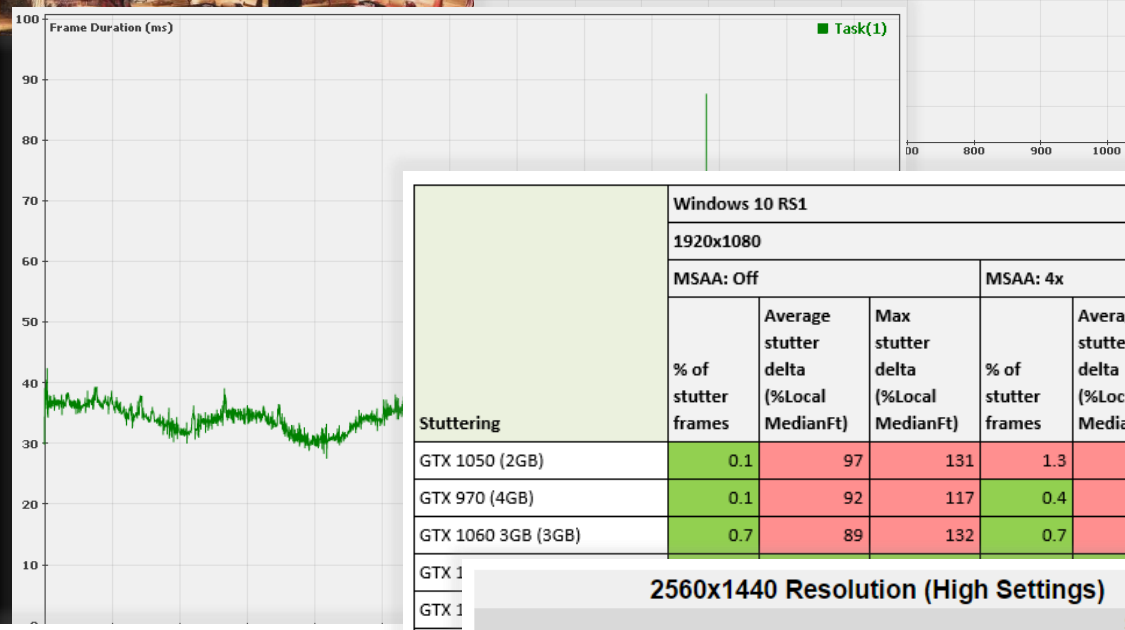
Jaakko Haapasalo (NVIDIA)

PC Testing

TWIMTBP Labs:

- 7 months
- 26 builds
- 10 Stutter & performance tests
- 5 Min & Rec Spec tests
- 3 TRC reviews





Stuttering	Windows 10 RS1				
	1920x1080				
	MSAA: Off			MSAA: 4x	
	% of stutter frames	Average stutter delta (%Local MedianFt)	Max stutter delta (%Local MedianFt)	% of stutter frames	Avera stutte delta (%Loc Media
GTX 1050 (2GB)	0.1	97	131	1.3	
GTX 970 (4GB)	0.1	92	117	0.4	
GTX 1060 3GB (3GB)	0.7	89	132	0.7	
GTX 1					
GTX 1					
GTX 1					
GTX 1					
GTX 1					

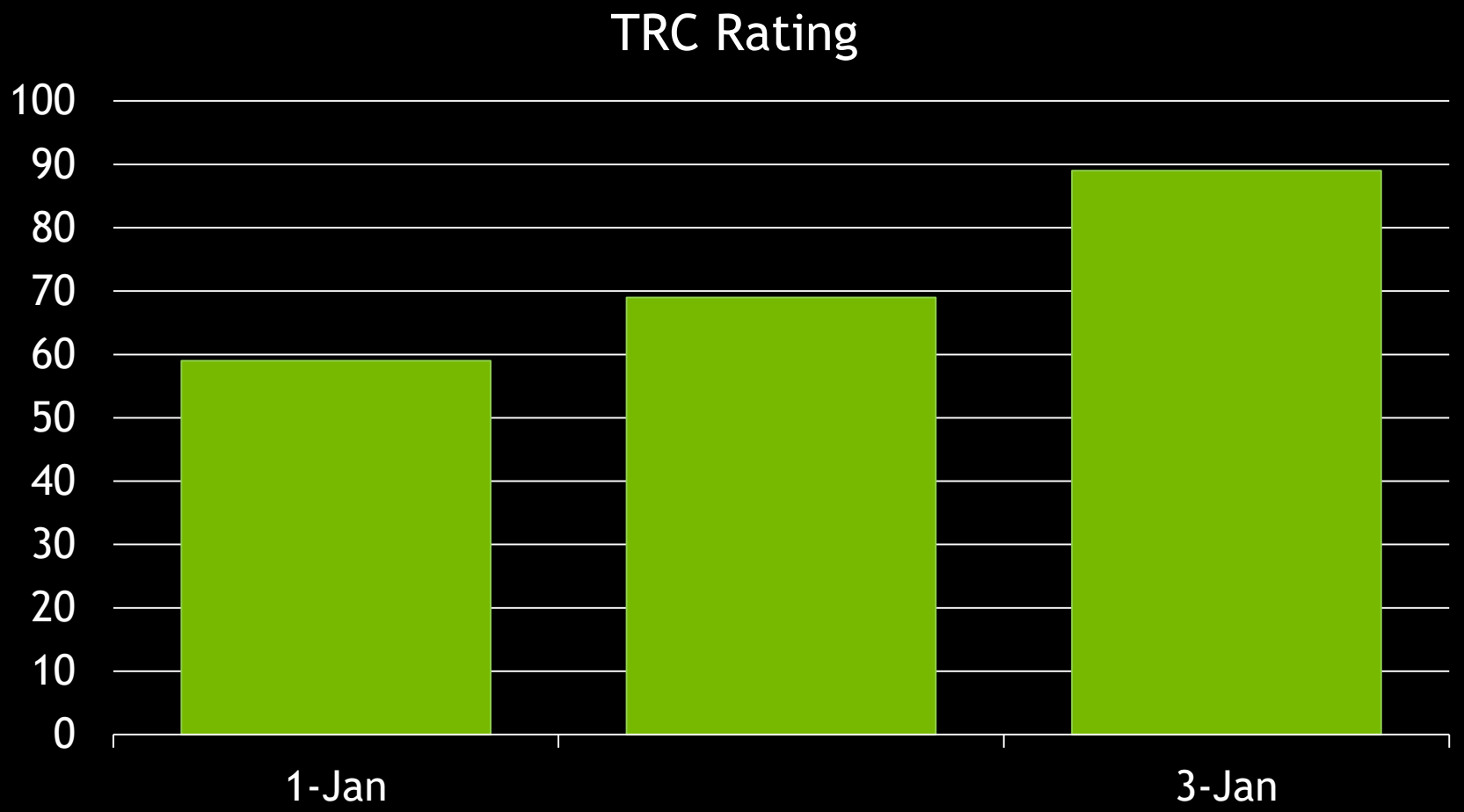
DX11	Windows 10 RS1					
	1920x1080		2560x1440		3840x2160	
	MSAA: Off	MSAA: 4x	MSAA: Off	MSAA: 4x	MSAA: Off	MS
GTX 1050 (2GB)	27.8	12.3				
GTX 1050 TI (4GB)	29.1	13.3				
GTX 970 (4GB)	36.6	18.9	24.7	11.4		
GTX 1060 3GB (3GB)	34.8	18.9	27.4	12.1		
GTX 1060 6GB (6GB)	46.7	22	31.3	13.8		
GTX 1070 (8GB)	61.7	29.5	42.9	18.5	23	9
GTX 1080 (8GB)	72.4	36.2	52.1	22.4	28.7	11
GTX 1080 2-Way SLI						

2560x1440 Resolution (High Settings)

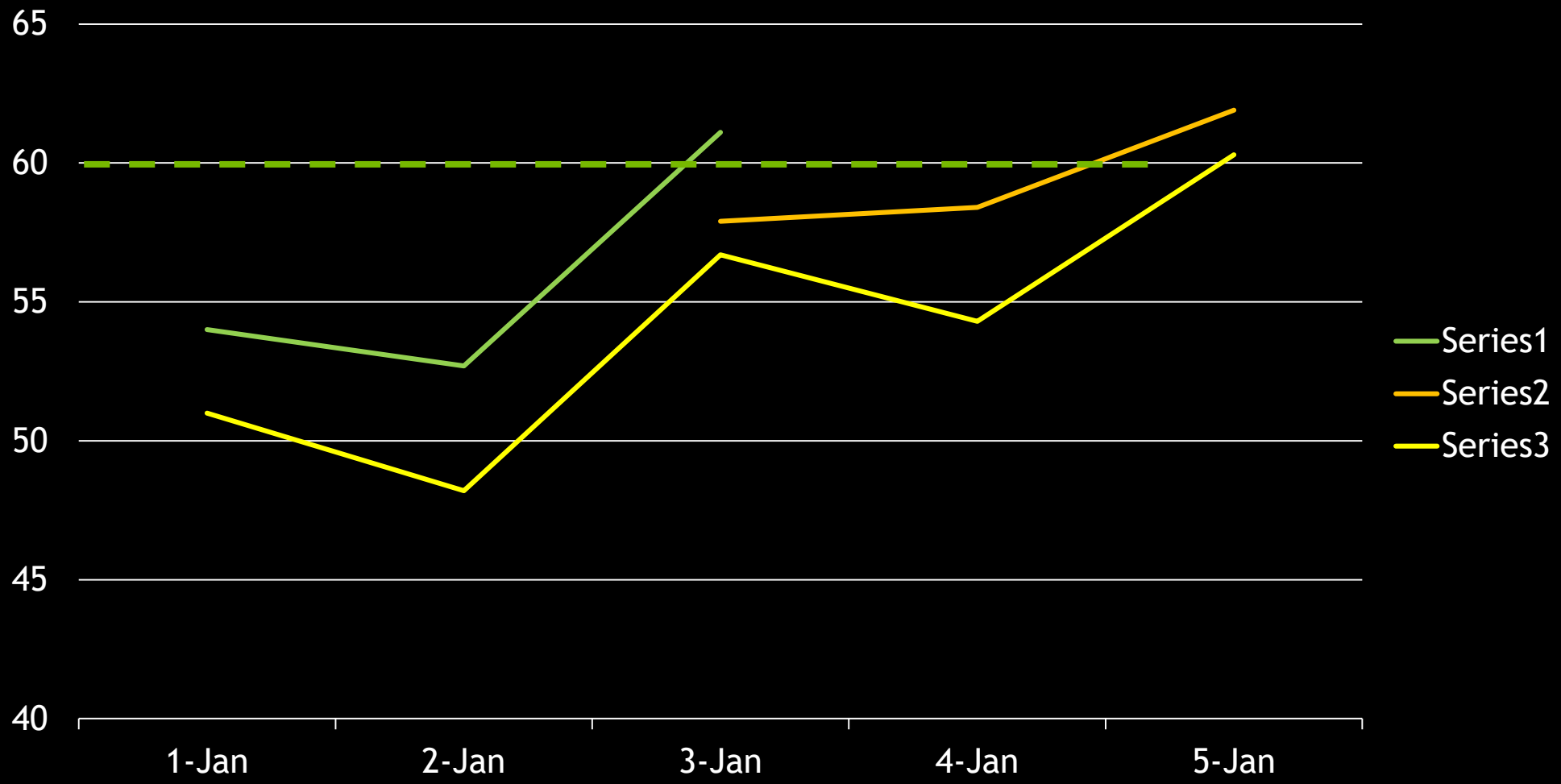
GPU	CPU	System RAM	Average FPS	Min FPS
GTX 970	i3-6300	16GB	40.8	33
GTX 970	i5-6600K	16GB	41.9	34
GTX 970	i7-6700K	16GB	40.2	33
GTX 1050Ti	i3-6300	16GB	28.9	24
GTX 1050Ti	i5-6600K	16GB	28.3	23
GTX 1050Ti	i7-6700K	16GB	28.4	23
GTX 1060-3GB	i3-6300	16GB	44.3	36
GTX 1060-3GB	i5-6600K	16GB	45.3	37
GTX 1060-3GB	i7-6700K	16GB	41.9	34
GTX 1060 6GB	i3-6300	16GB	45.4	37

GDC 17

TRC Progression



Min & Recommended Specs: 1K & 2K



Partnering with NVIDIA

Marius Tudorache (Ubisoft)

New NVIDIA-Ubisoft collaboration process

- Transparent communication
- Smoke-tested builds
- Delivery of builds and performance reports
- TRC simulations
- Post-Mortem and learnings across projects
- Dedicated JIRA for each project - tracking bugs outside of e-mails

! Think co-dev instead of tech support !

PC Testing – UBI PC Requirements

- 13 months (1st check - October 2015)
- 320+ builds (WD2-GAME-PC2->PC15x + RAW)
- ~28 performance/TRC tests
- ~28 Min & Rec Spec tests
- 7 TRC official reviews (Alpha/Beta/Master/D1P)

Ubisoft - Winning PC gamers

After 20 years of PC releases:

- Knowledge & Information Sharing Management for PC
  - Internal PC Summits
- Improving PC Technical Requirements
- Developing PC Communities - internally, externally, E-Sports
- Improving communication with PC gamers

Current UBI TRC Structure (WD2 proto.)

101 Tech. requirements

- Short title – for easy referencing
- Requirement description
- Terminology
- Remarks
- Intent
- Exemption
- TRC Rating per requirement – different for each milestone
- Overall Rating – work in progress

Using target TRCs as tech design

- Clarity
- Transparency
- Conformity
- Predictability
- Continuity

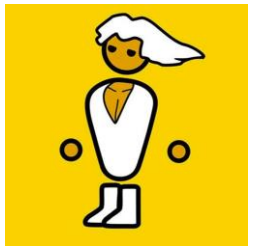
Major Challenge: Public Tech Requirements (open-sourced to communities)

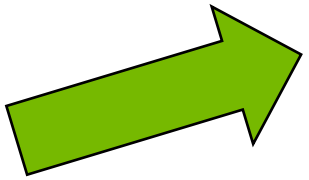
WD2 communicated Min & Reco

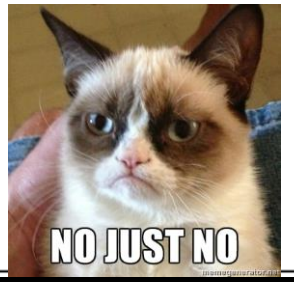
We wanted to express:

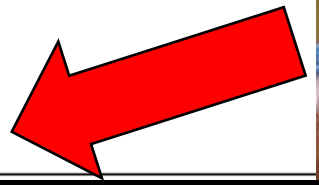
- Performance-based specs split per GPU series
- Coverage (old to new gen)
- Clarity for casual gamers

	KEPLER		KEPLER refresh		MAXWELL		PASCAL	
12500							GeForce GTX 1080	12612
12000								
11500					GeForce GTX 980 Ti	11532	GeForce GTX 1070	11595
11000								
10500								
10000								
9500							GeForce GTX 1060	9406
9000			GeForce GTX 780 Ti	8968				
8500					GeForce GTX 970	8652		
8000			GeForce GTX 780	8017				
7000								
6500								
6000			GeForce GTX 770	6146	GeForce GTX 960	5913		
5500	GeForce GTX 680	5715						
5000	GeForce GTX 670	5381	GeForce GTX 760	4951	GeForce GTX 950	5241		
4500	GeForce GTX 660 Ti	4707						
4000	GeForce GTX 660	4119						
3500								
3000								
...								
0								









PASSMARK VALUES

Detecting and Eliminating Stutter

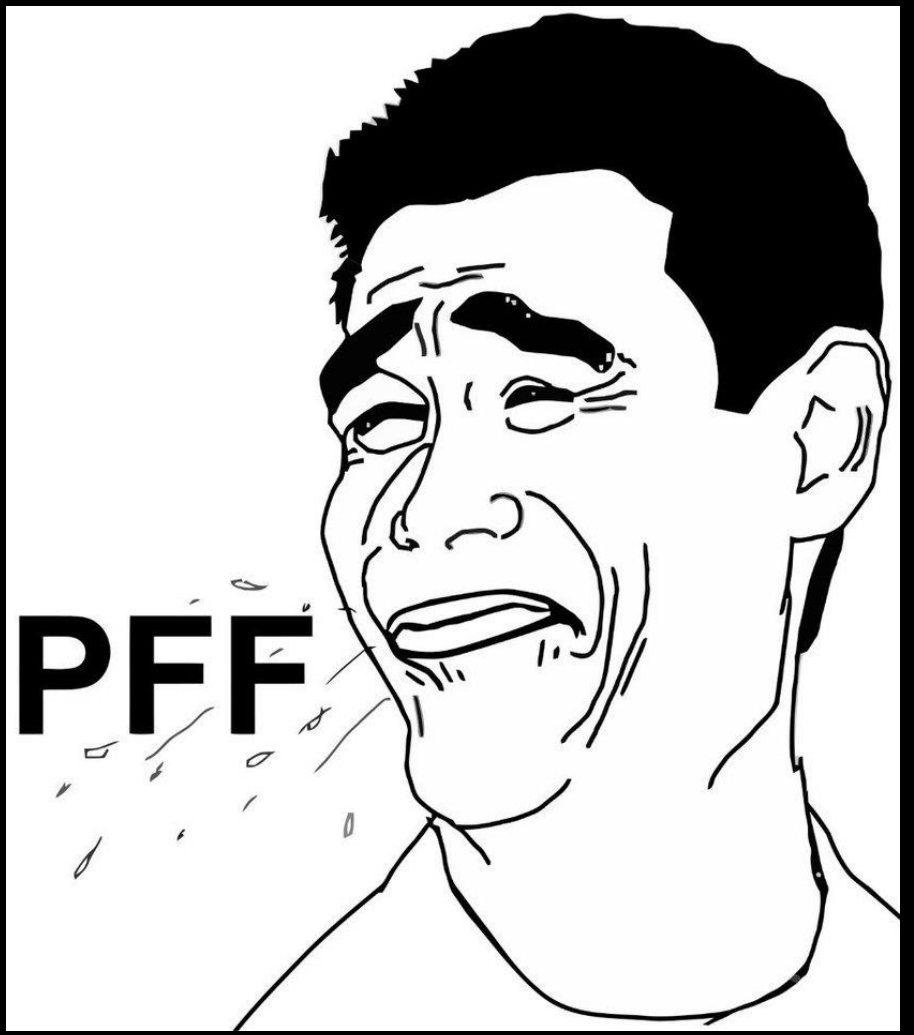
Farid Rzaev (NVIDIA) and Oleh Kuznetsov (Ubisoft)

Agenda

- Stutter overview
- Stutter detection
- Stutter analysis
- Fixing stutter
- Results

Stutter? Hitches?

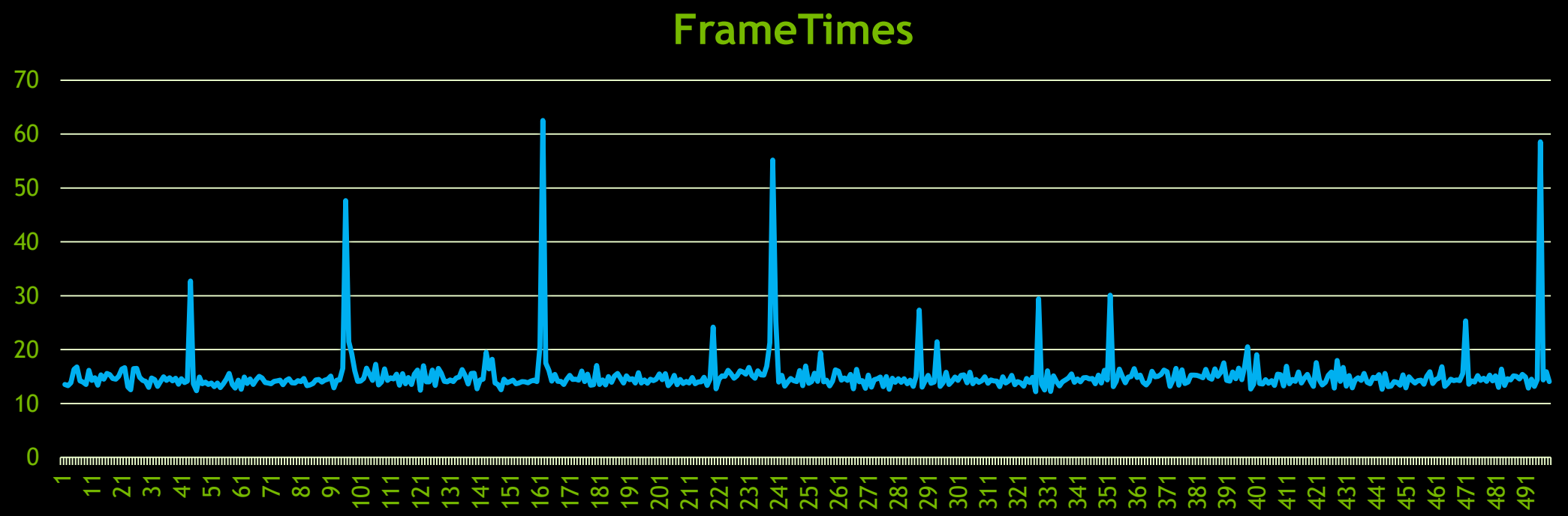
Everybody knows what it is….



Let’s Define

What stutter/hitches are?

- Inconsistency in performance between frames



Player’s Point of View

Occasional freezes

Uncomfortable feeling under **recommended specs**

Stutter is a Huge Thing

Focus on our experience with Watch Dogs 2

Catching up issues

- Tools

Fixing issues

- Methods / Approaches

Finding Stutter Cases

Watch Dogs 2 is an **open world** action-adventure game

- Each stutter case should be covered by a benchmark

In-game Benchmark

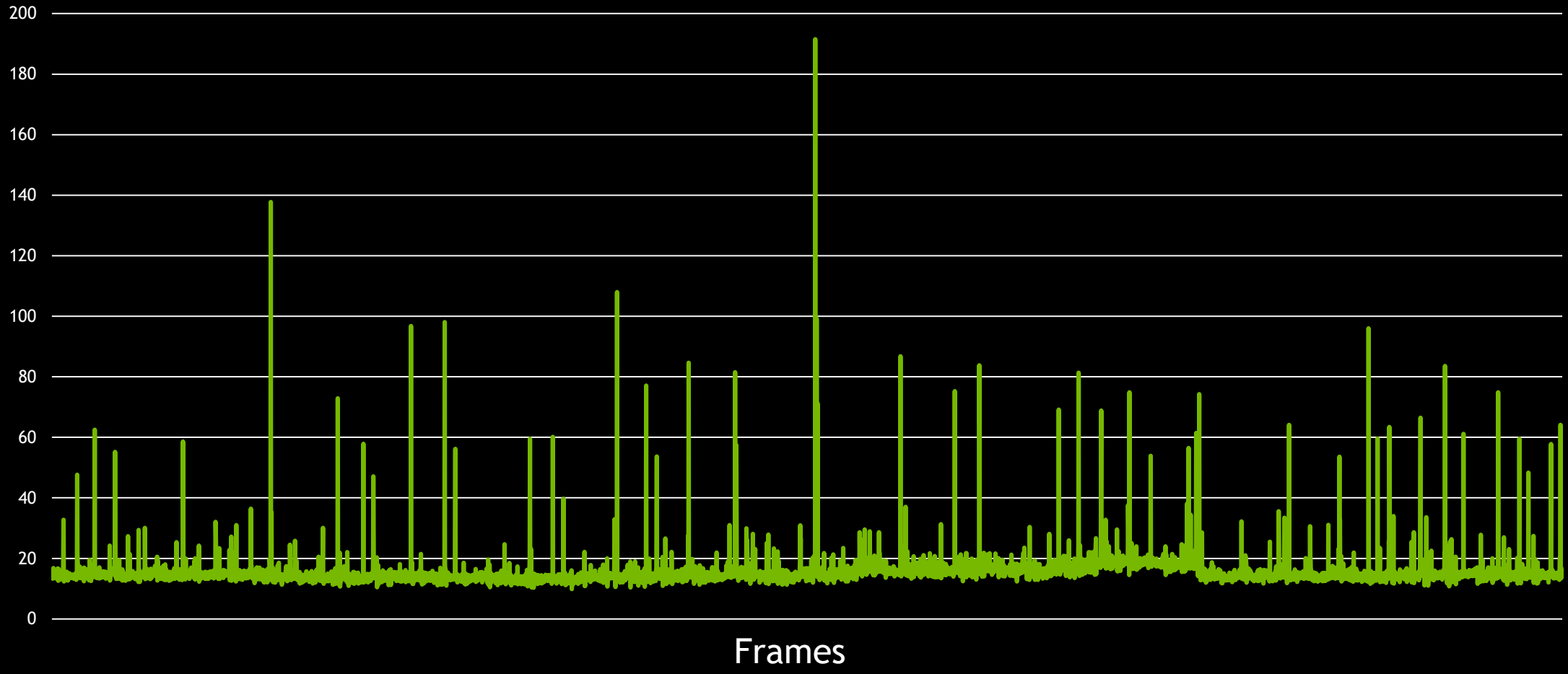
We had an internal in-game benchmark, but it **didn't cover all of the cases.**

Two Benchmarks

In-game

Fast Car

Frametime graph (ms)



Tools

- GPUView
- Concurrency visualizer (**CV**)

Stutter issues

1. GPU Memory consumption  GPU View / Afterburner
2. CPU Workload Inconsistency  GPU View / CV
3. Bursts of creates / destroys  GPU View
4. Page faults  CV / GPU View

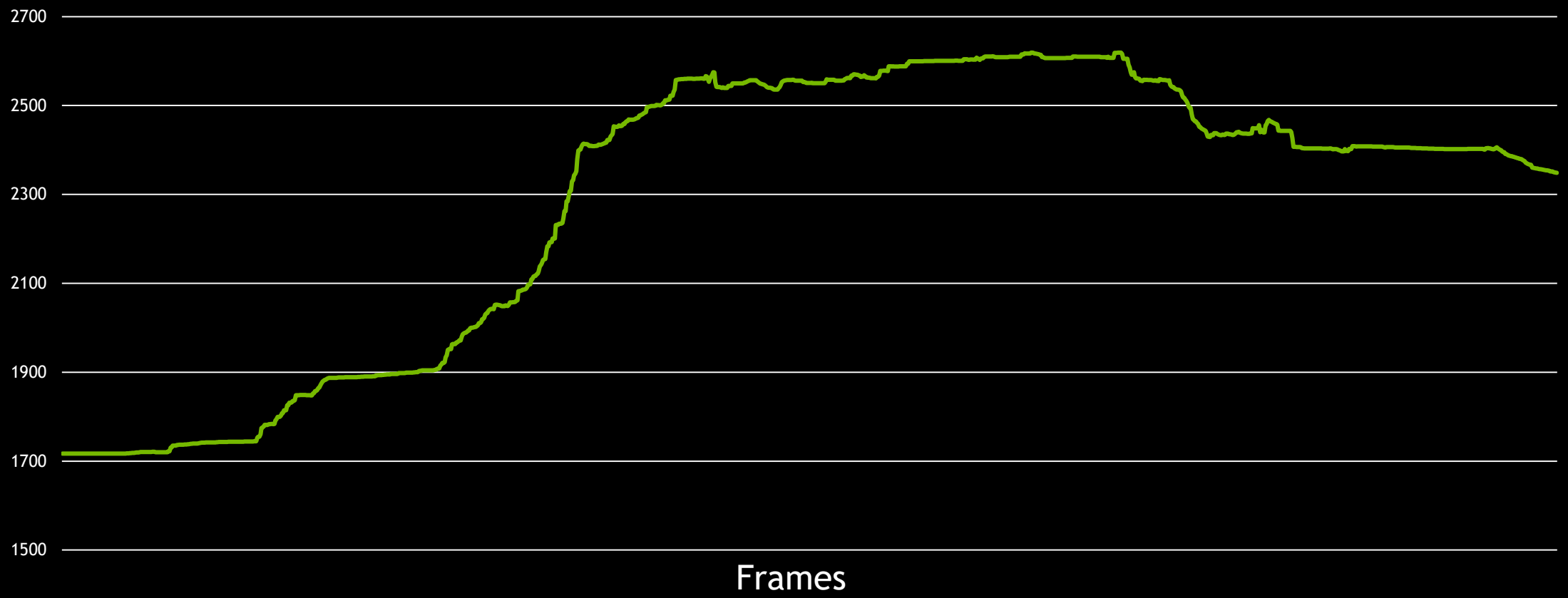
GPU Memory consumption

- Running out of the video memory
- Didn’t account some video memory for the driver (~10%)

Tools:

- GPUView eviction events
- GPUView reference charts

GPU Memory Usage (MB)



UBI – Memory Consumption

Approaches

- Check VRAM usage (lighting, models, textures, post effects, …)
- Give artists the possibility to tune MIP maps skipping on a per texture basis
- Look for the allocated but not used resources.
- WD2: For the low settings we skipped Global Illumination probes for Far Away objects

Challenges

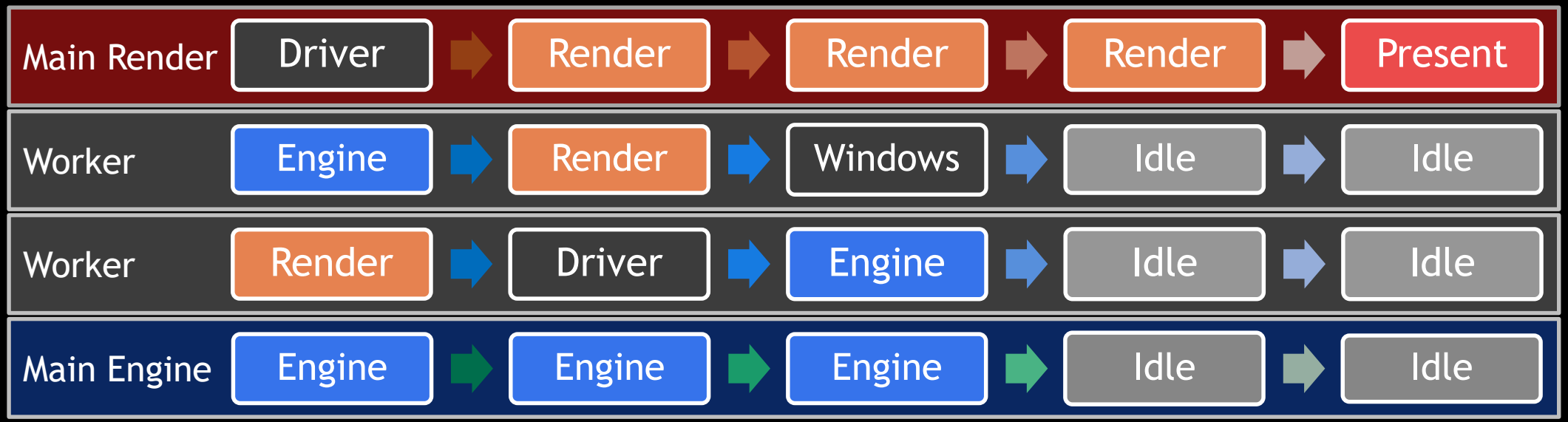
- Visual quality on the low settings
- Textures in RAM if not enough VRAM

CPU Utilization Inconsistency

UBI – CPU Utilization Inconsistency

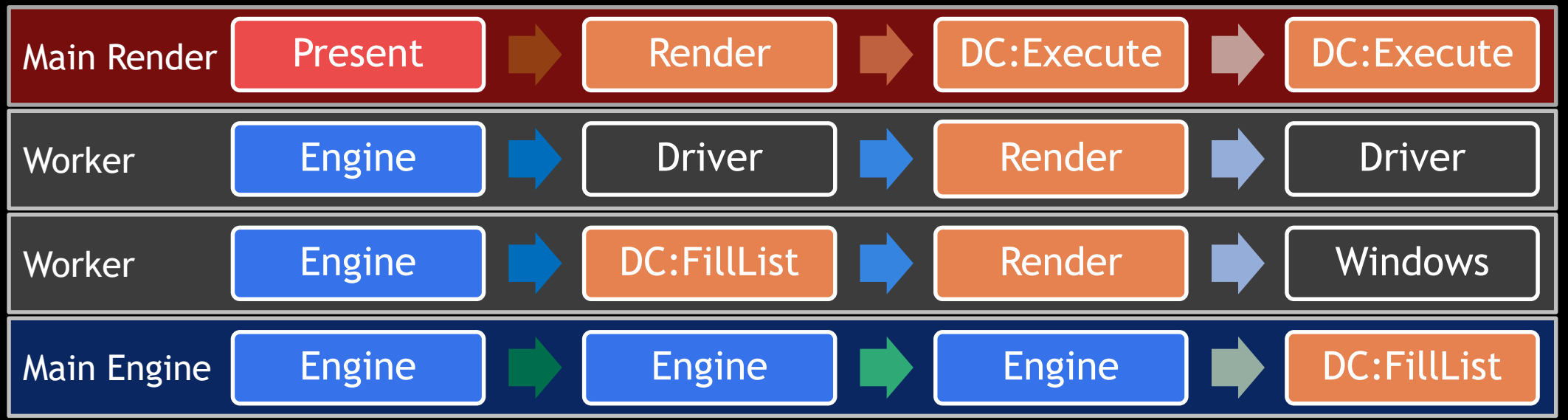
WD2: We use all CPU threads, but leave some idle time for a driver and other processes

Frame structure:



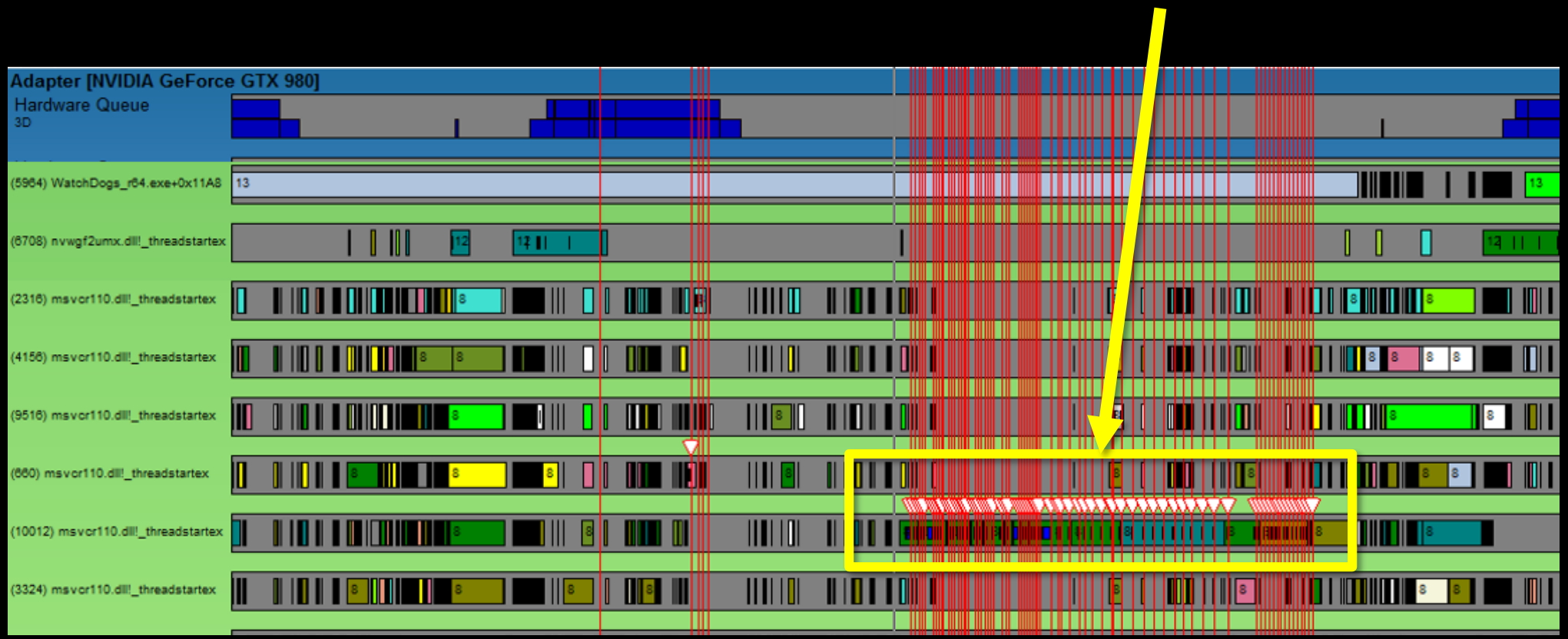
UBI – CPU Utilization Inconsistency

- Multithread rendering (Using deferred context)
- Use Present time to do engine jobs



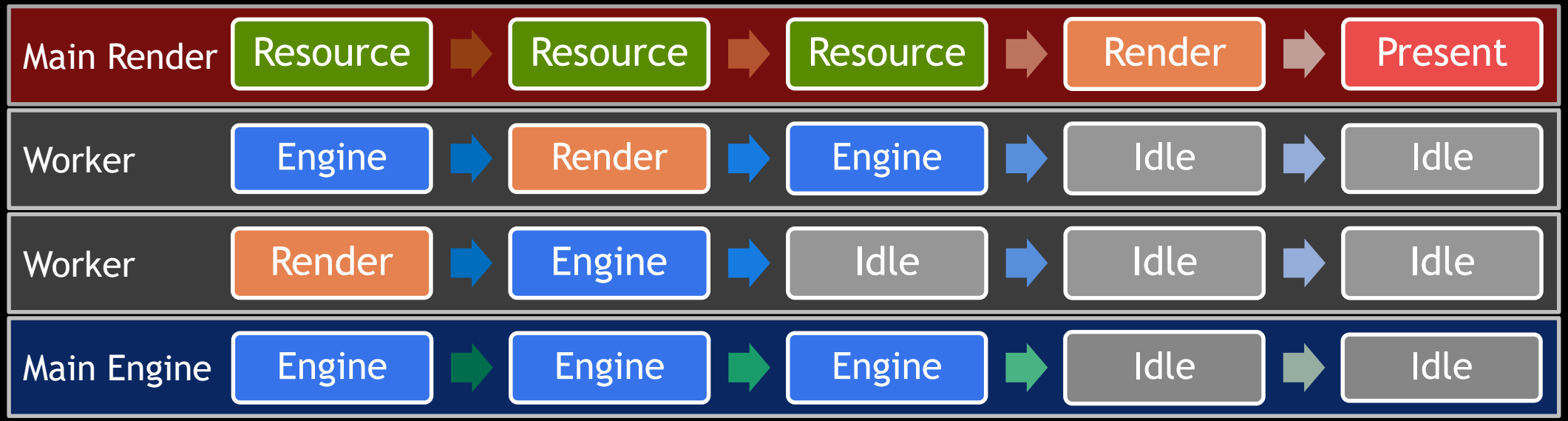
Bursts of creates / destroys

Too many of creates / destroys of resources **on the render thread**



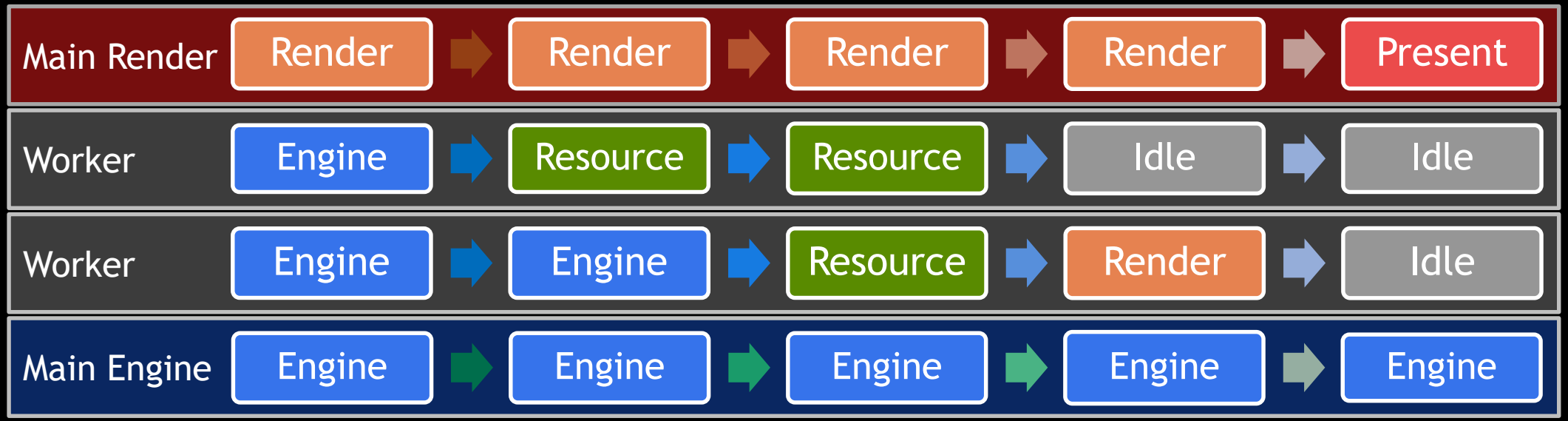
UBI – Resource Management

Creating resources on the main render thread:



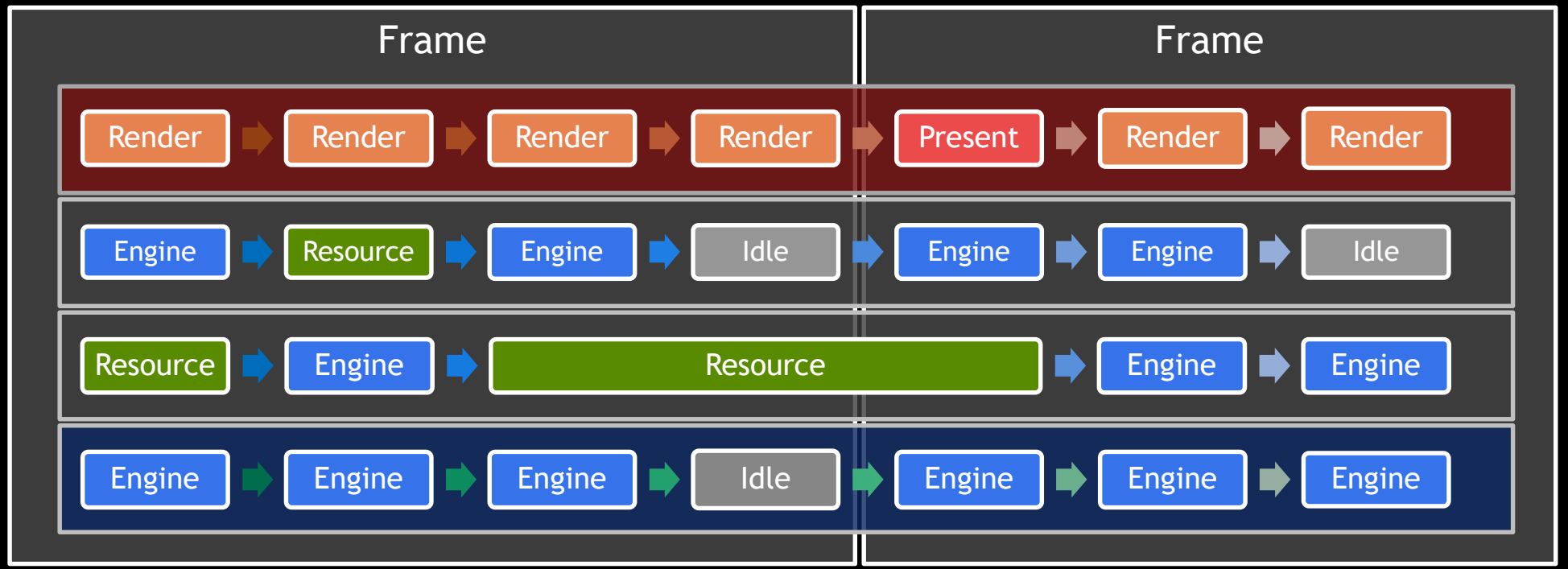
UBI – Resource Management

Creating resources on the worker threads:



UBI – Resource Management

Resource jobs between the frames:



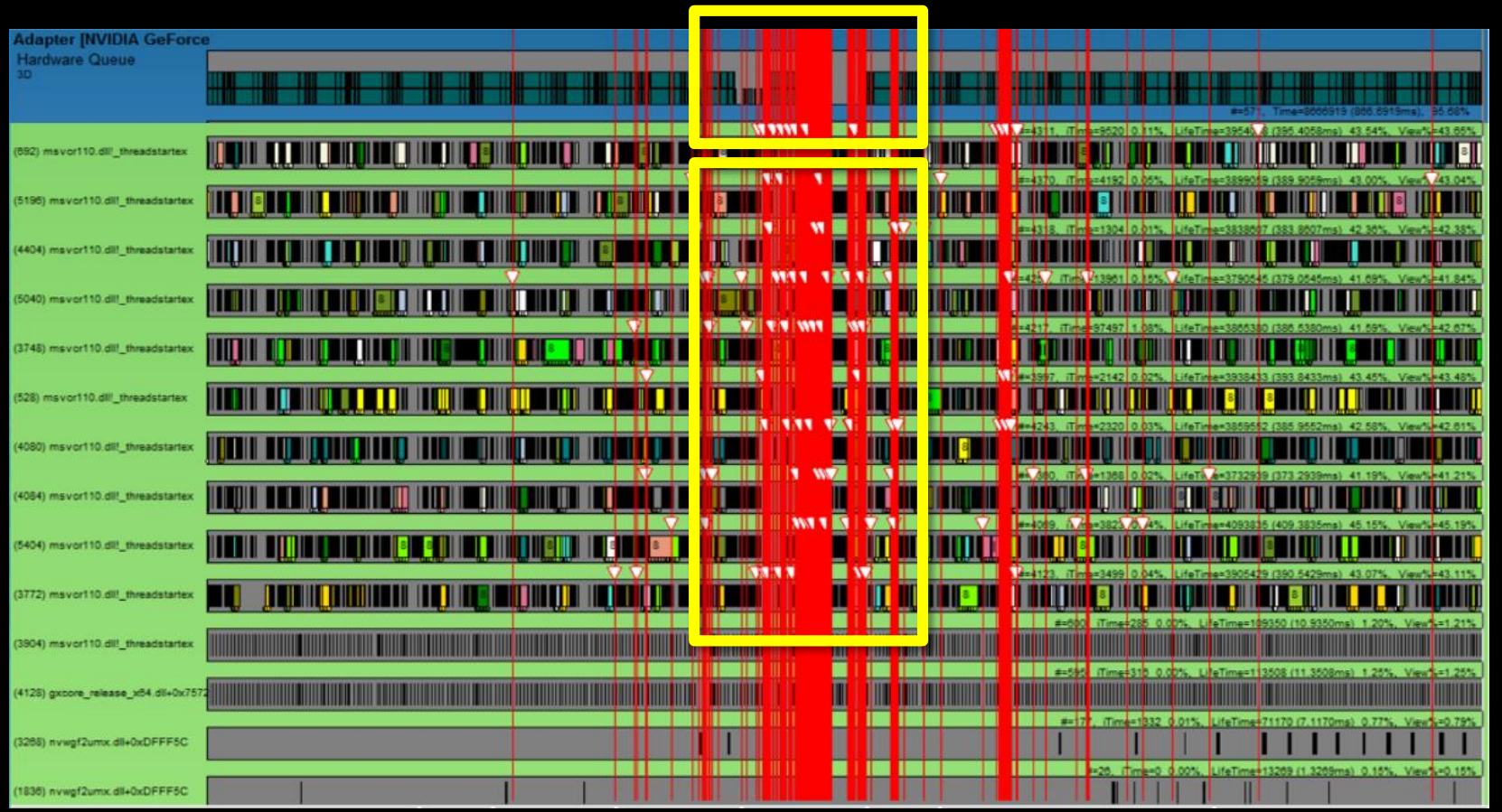
UBI – Resource Management

Approaches

- Avoid resource creation on the main render thread

Bursts of creates / destroys

Too many of creates / destroys of resources on multiple threads



UBI – Bursts of creates / destroys

Approaches

- Limit resource creation per frame
- The lower minimum limits you set – the less spikes you have
- Use texture pool to decrease Release calls
- Use typeless formats in texture pool

Challenges

- Resource Release can take significant amount of time but is hard to be measured

Page Faults - HDD specific

- HDD specific Page Faults that lead to stutter
- Windows cache's HDD reads
    - Page Faults were only seen on the FIRST run of the game

Page Faults - CV

UBI – Using the System File Cache

Approaches

- Any free memory on Windows PC may be used as the file cache
- Fill windows file cache by game data files before they are requested
- Use logos/intro videos and idle menu time to fill the cache
- Cache the most important files first

Challenges

- Not enough time to cache the entire game
- Not enough free memory to cache the entire game

Result

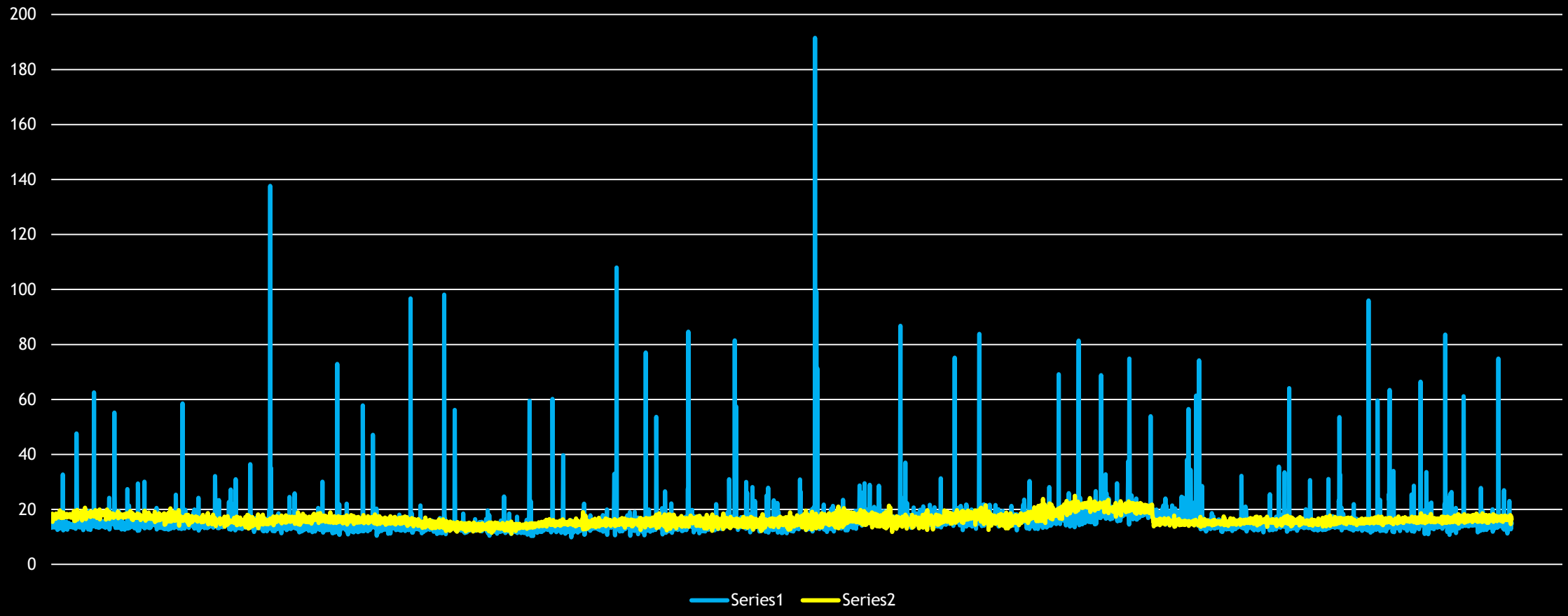
- It took us 4-5 months: Start 08/2016 – End 12/2016

- Weekly meetings
- Weekly builds with updates and summaries
- During the week: local skype chats and DAILY calls

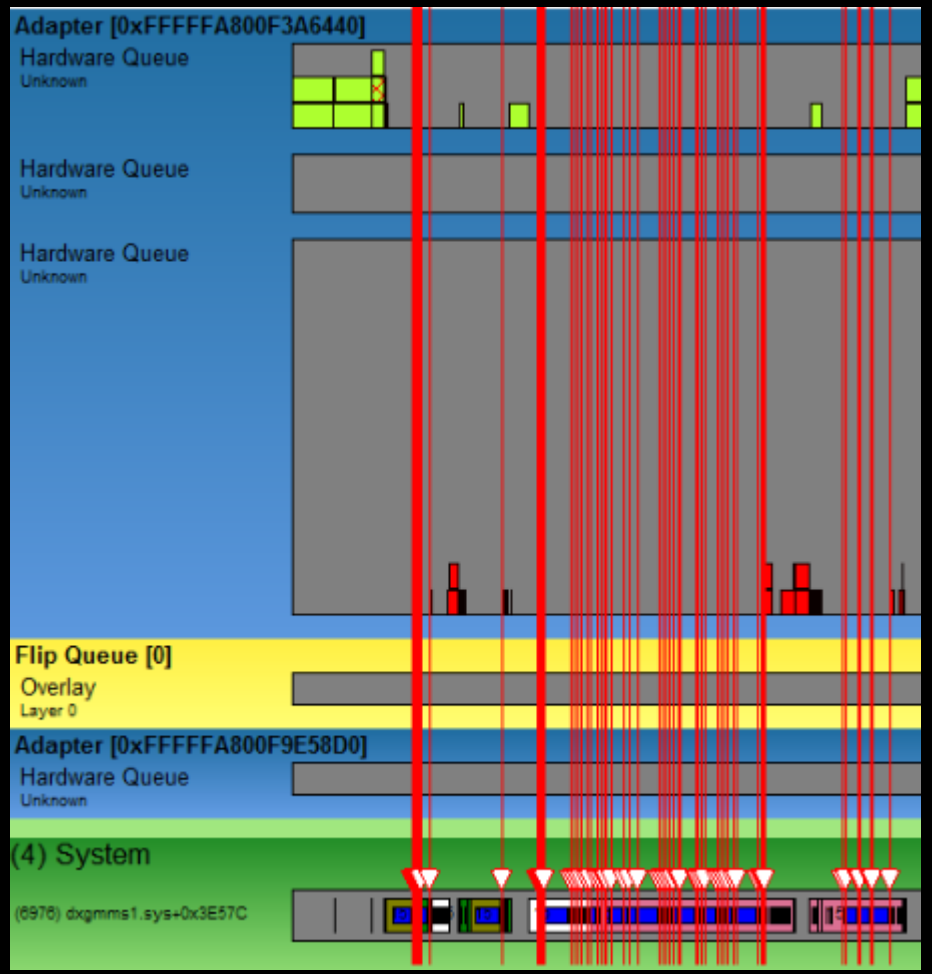
- Super fast responses on both sides:
    1. NVIDIA: catching and reporting issues, suggestions
    2. UBI: fixing and sending new builds in a short time

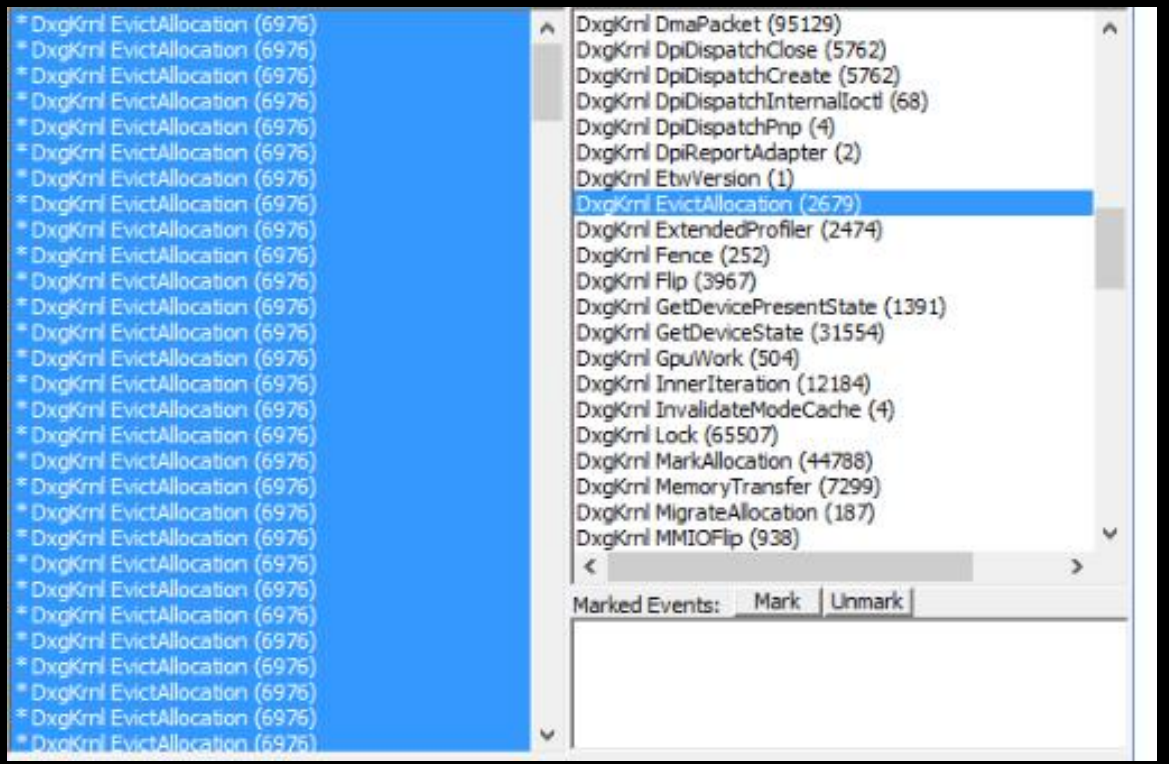
Result

Feel comfortable under **recommended specs**



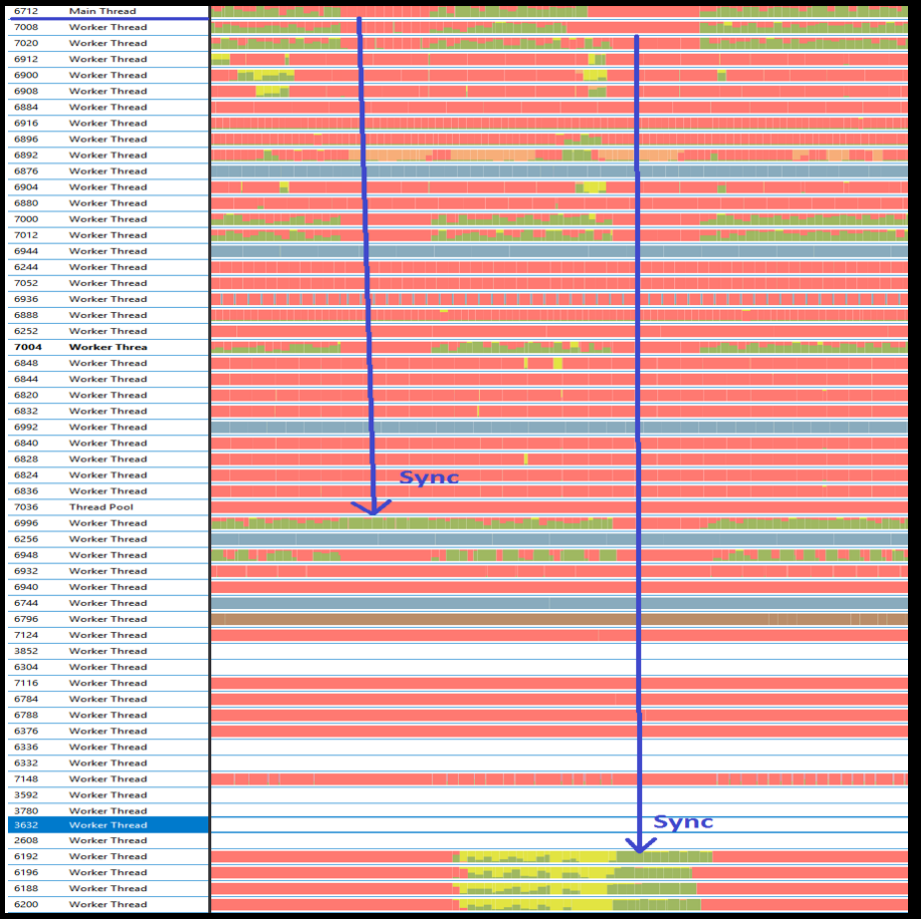
GPU Memory eviction





GPU Memory Reference Charts

CPU Workload Inconsistency



References

- Stuttering in Game Graphics: Detection and Solutions - Cem Cebenoyan
- Analyzing Stutter – Mining More from Percentiles - Iain Cantlay
- SLI and Stutter Avoidance - Iain Cantlay, Lars Nordskog

Learnings

Take Home

- Apply technical validation criteria before designing
- Adapt code as well as design for best results
- Playtest your game with casual AND enthusiast hardware
- UBI PC Requirements and NVIDIA TRCs are aligned

Take Home

- NVIDIA Technical Requirements Checklist is a great way to get started focusing on the PC as a Platform
- Low performance and Stutter still pose major risks for games today; isolate them early, and iterate aggressively (come talk to us!)
- Partnering with the Game Ready Quality Program will help us support your vision for superior PC Quality

Thank you!

Email jhaapasalo@nvidia.com for a sneak peek

Look out for more information on
http://developer.nvidia.com soon!