



Assessment 1 of 2 – Graphics Programming

# VR GRAPHICS DEVELOPMENT



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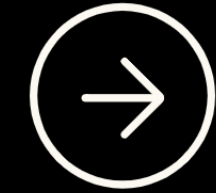


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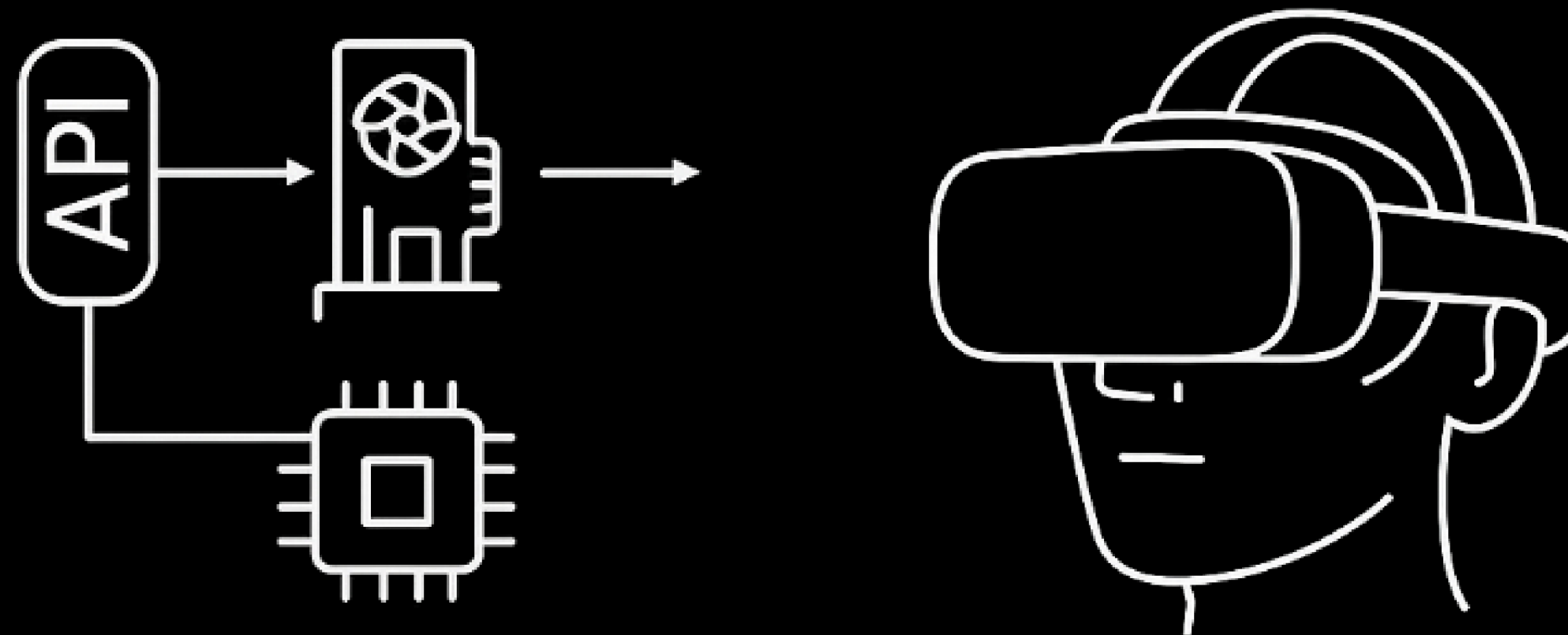
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# INTRODUCTION



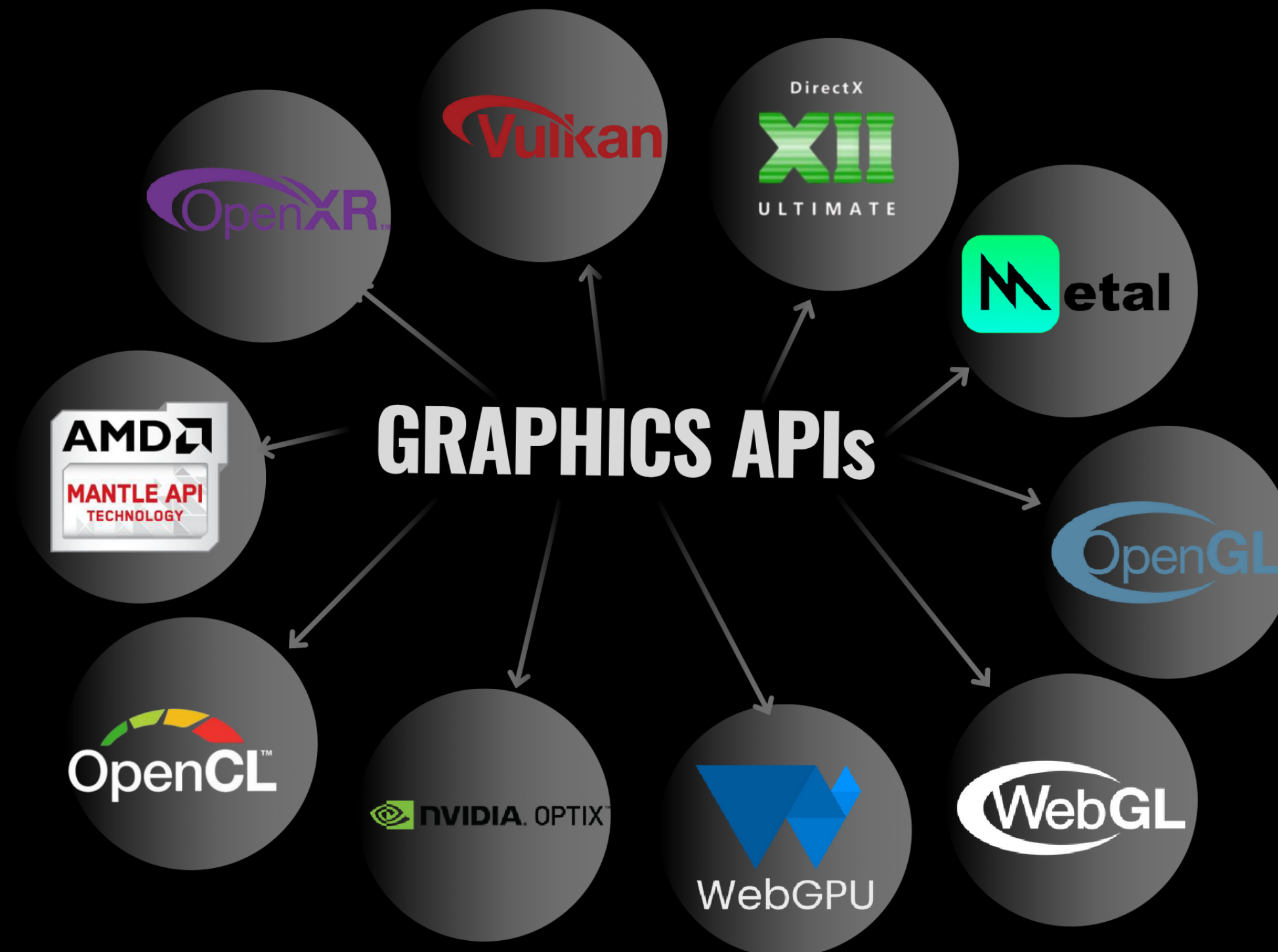
This presentation explores the development of graphics in Virtual Reality, focusing on the evolution and significance of Graphics Application Programming Interfaces. It examines how these APIs power the VR graphics pipeline, considers different pipeline types, and evaluates their impact on performance. Additionally, it highlights market opportunities, adoption trends, and emerging advancements in VR, concluding with recommendations for future progress in the field.



# WHAT IS GRAPHICS API ?

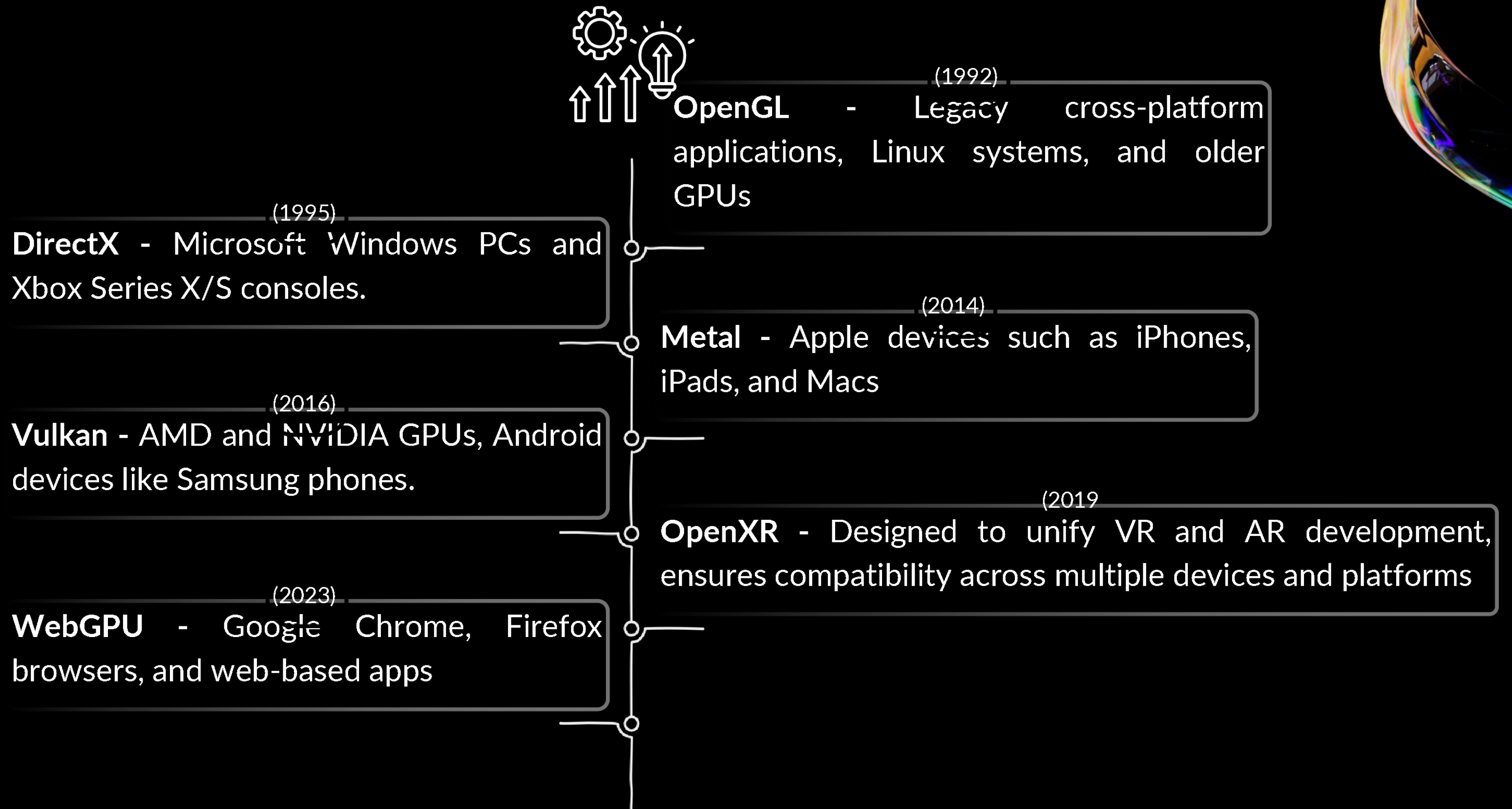


According to Jose (2024), Application Programming Interfaces are software tools that act as a middleman between high-level code and low-level operations on hardware like Graphics Processing Unit (GPU), which interact with the Central Processing Unit (CPU), memory subsystems, and peripherals to handle tasks such as rendering graphics and processing data.





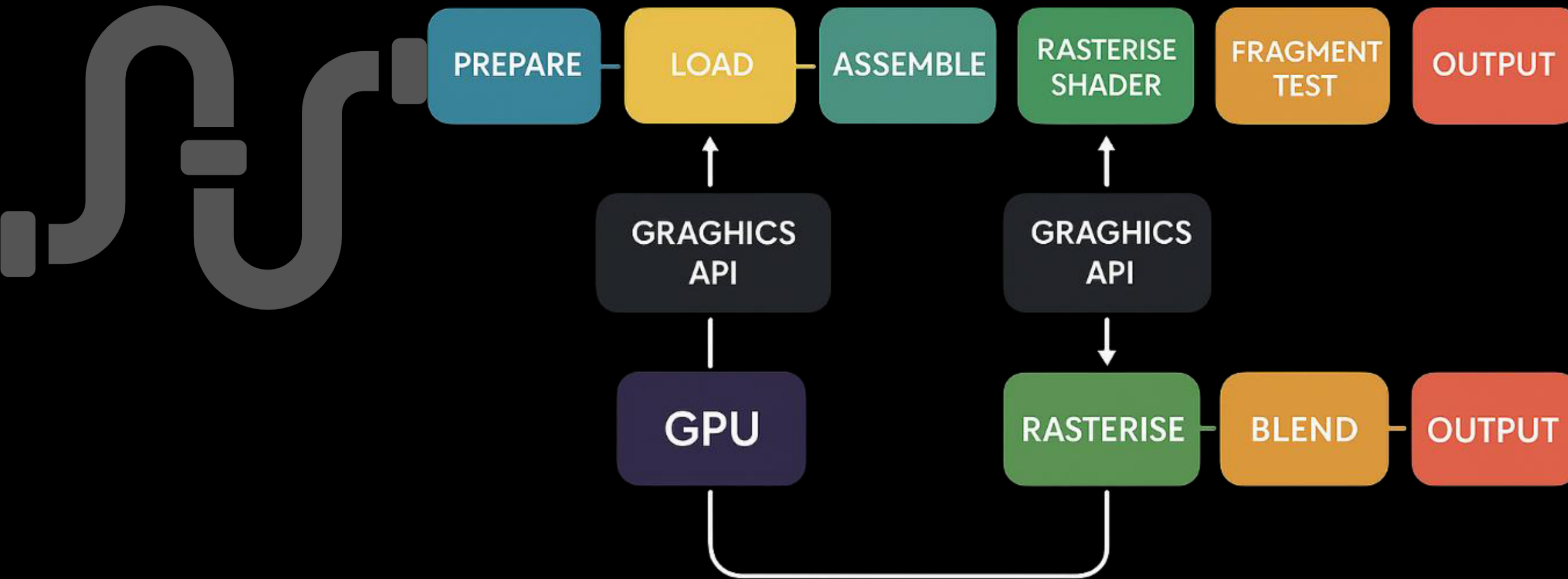
# GRAPHICS API EVOLUTION



# WHAT IS GRAPHICS PIPELINE ?



According to Jose (2024), Application Programming Interfaces are software tools that act as a middleman between high-level code and low-level operations on hardware like Graphics Processing Unit (GPU), which interact with the Central Processing Unit (CPU), memory subsystems, and peripherals to handle tasks such as rendering graphics and processing data.



arXiv (2025) examines advancements in graphics pipelines for virtual reality, with a focus on optimising hardware to enhance rendering techniques such as radiance fields. It is outlined in arXiv (2025) studies how modern graphics pipelines merge programmable and fixed-function elements to deliver seamless, high-quality, real-time rendering—an essential component in creating immersive VR experiences.

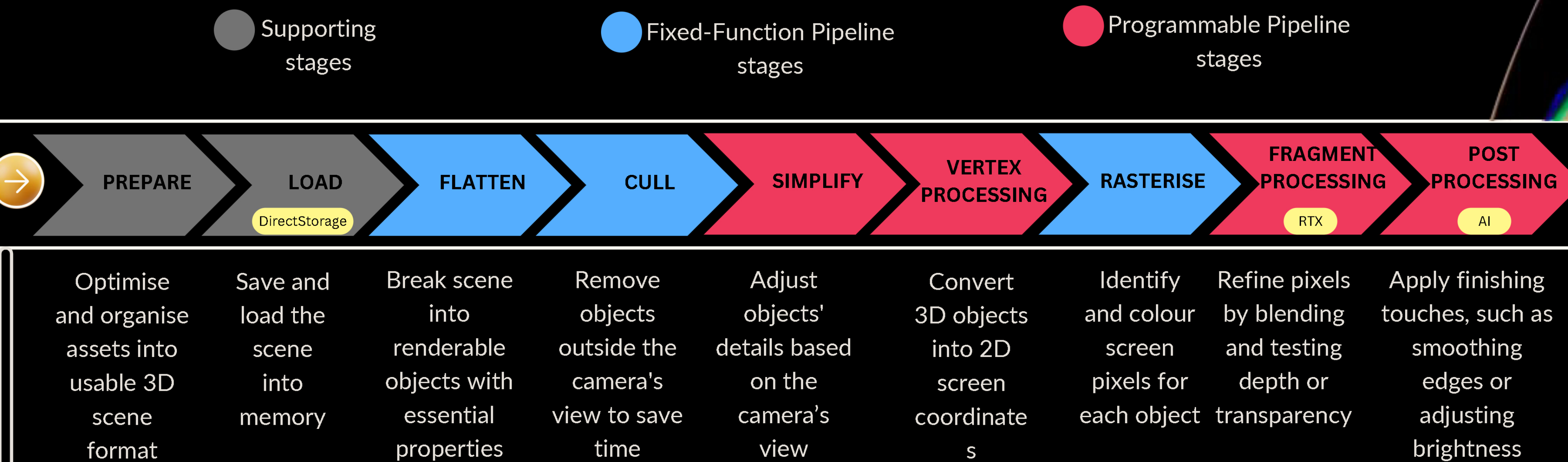


# GRAPHICS PIPELINE TYPES



IEEE (2019) identifies the Fixed-Function Pipeline as a legacy method of rendering graphics, where processes were rigid and predefined. Developers had limited ability to customise the pipeline, relying only on configurable parameters such as matrices, which significantly constrained flexibility. In contrast, IEEE (2019) highlights the modern Programmable Pipeline, which allows developers to design custom shaders. These shaders control how the GPU processes vertices, geometry, and fragments, providing unparalleled customisation and enabling complex visual effects. As such, the programmable approach has become the contemporary standard for rendering technology.

Wetzstein (2025) explains how the pipeline transforms 3D scenes into 2D images, which is a critical process for rendering Virtual Reality environments, and is widely used in tools like Unreal Engine and Unity for VR development.



# RECOMMENDATION



**Vulkan**



DirectX  
**XII**  
ULTIMATE



**Metal**



**OpenGL**

## Applications

AAA & indie games,  
emulators, Linux gaming,  
mobile graphics

PC & Xbox gaming, high-end  
graphics applications

Apple-exclusive games,  
**AR/VR** apps, iOS/macOS  
graphics

Legacy software, CAD,  
cross-platform  
compatibility

## Features

- Low overhead, high performance
- Cross-platform
- Explicit GPU control

- Optimised for Windows & Xbox
- Ray tracing, mesh shaders
- Good driver support

- Optimised for Apple hardware
- MetalFX upscaling
- Low power consumption

- Easy to use
- Wide compatibility
- Older API, less optimised

## Performance & Efficiency

**High** – best for modern hardware

**High** – optimised for Windows & Xbox

**High** – best for Apple devices

**Medium** – less optimised, but widely compatible

## Ease of Use

**Hard** – steep learning curve, requires advanced coding

**Moderate** – easier than Vulkan, but still requires low-level programming

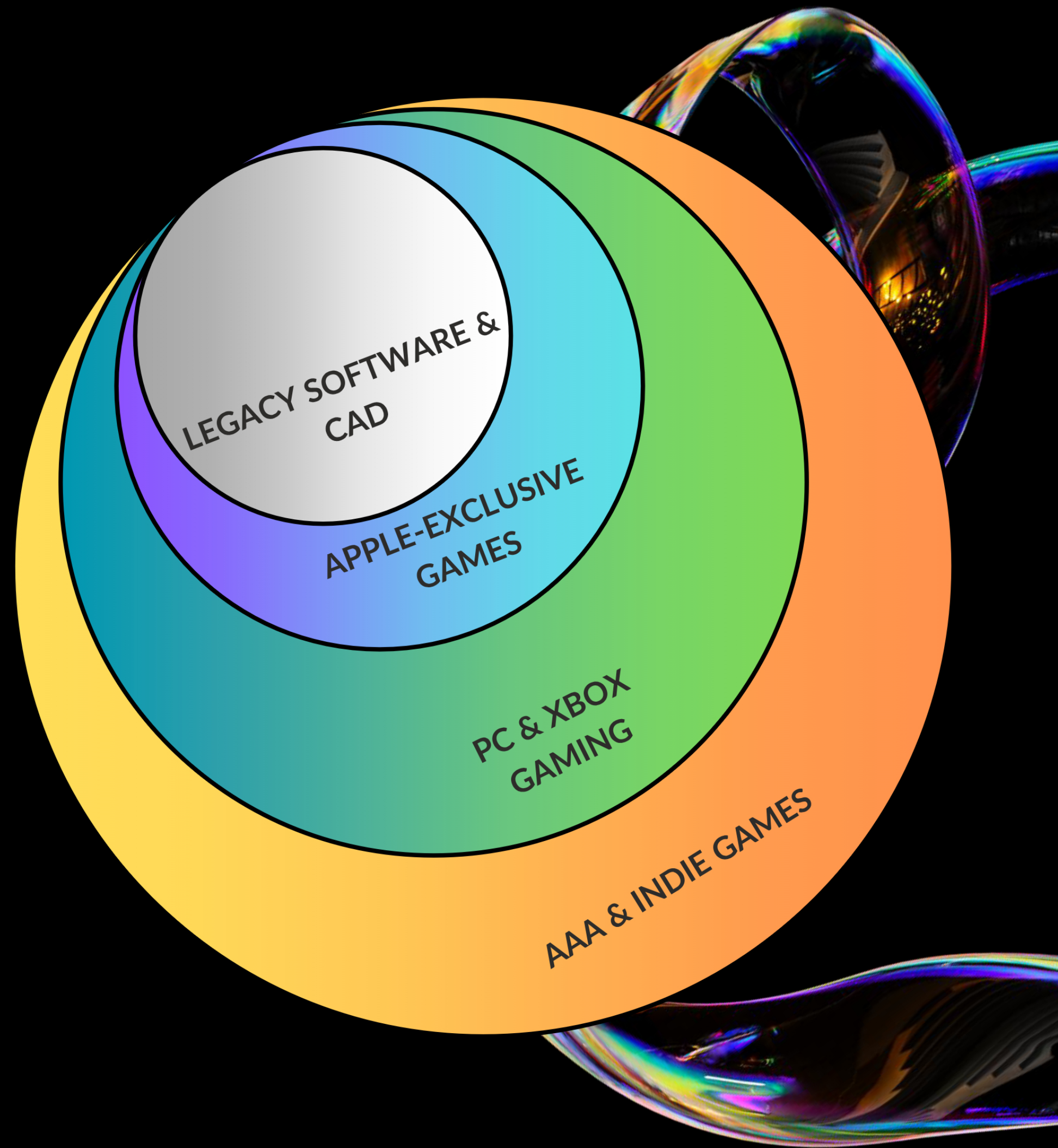
**Moderate** – easier than Vulkan, but Apple-specific

**Easy** – widely used, beginner-friendly, but outdated



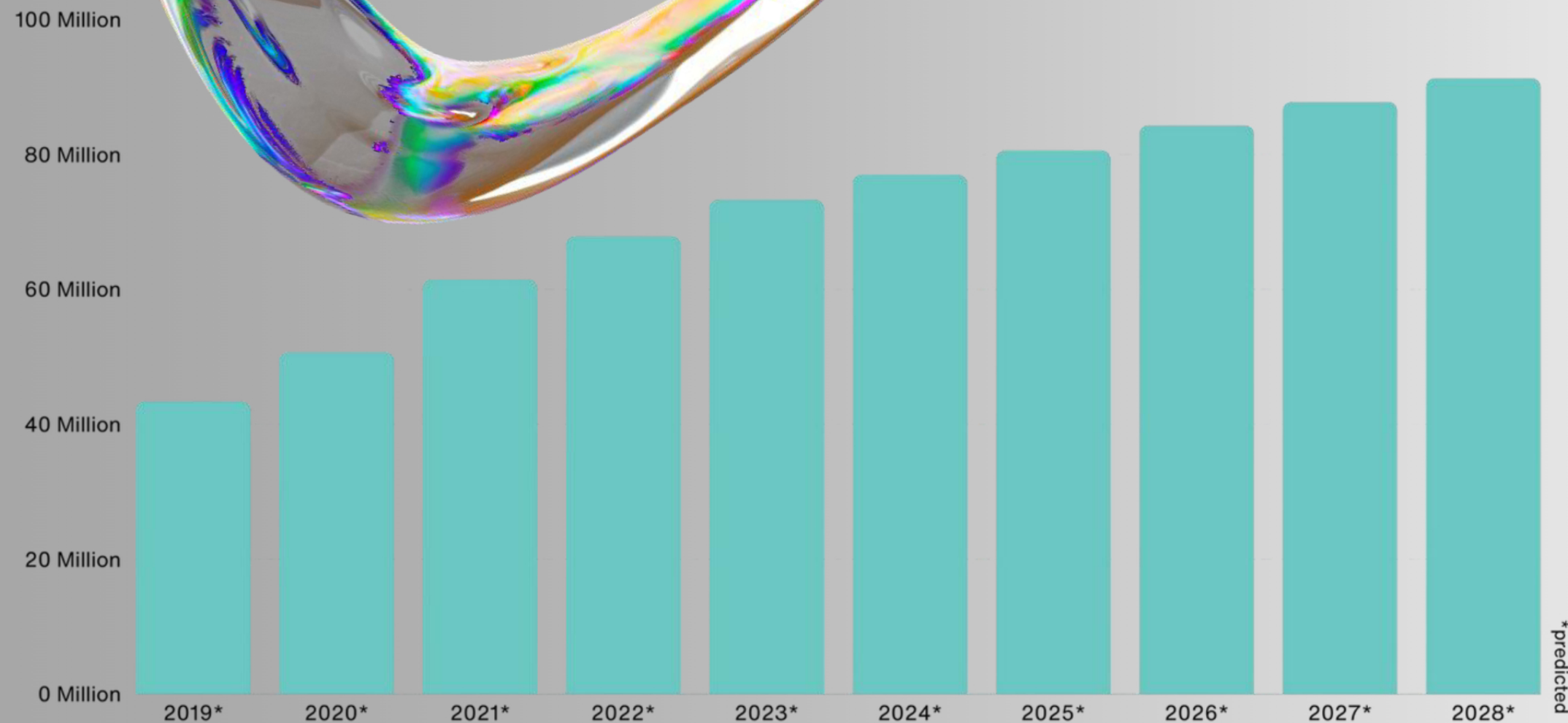
# MARKET POTENTIAL

- **AAA & Indie Games** – might dominate more than 50% of the market, but this would vary based on the growth of indie development compared to AAA studios.
- **PC/Xbox gaming** – likely overlaps significantly with AAA gaming due to the shared reliance on APIs like DirectX.
- **Apple** – exclusive games and **AR/VR** applications – might have smaller shares but are growing as **AR/VR** technology advances.
- Legacy software/CAD usage – could be declining as newer technologies emerge, so the percentage might be shrinking.





# TRACTION



Number Of VR Users In The United States

demand**sage**

Source: [demandsage.com](https://demandsage.com)

According to Phil (2023) the global VR market is experiencing rapid growth, with revenues projected to exceed £9.6 billion by 2024 and a compound annual growth rate of 18% from 2021 to 2028. In 2020, the United States alone recorded 83.7 million VR users, with numbers continuing to rise as adoption expands across industries such as gaming, healthcare, and education.

18% average annual revenue growth per year

78% of Americans are now familiar with VR technology

VR is most popular among users aged 18–34

Over 171 million people worldwide are actively using VR technology



# KEY VR TRENDS

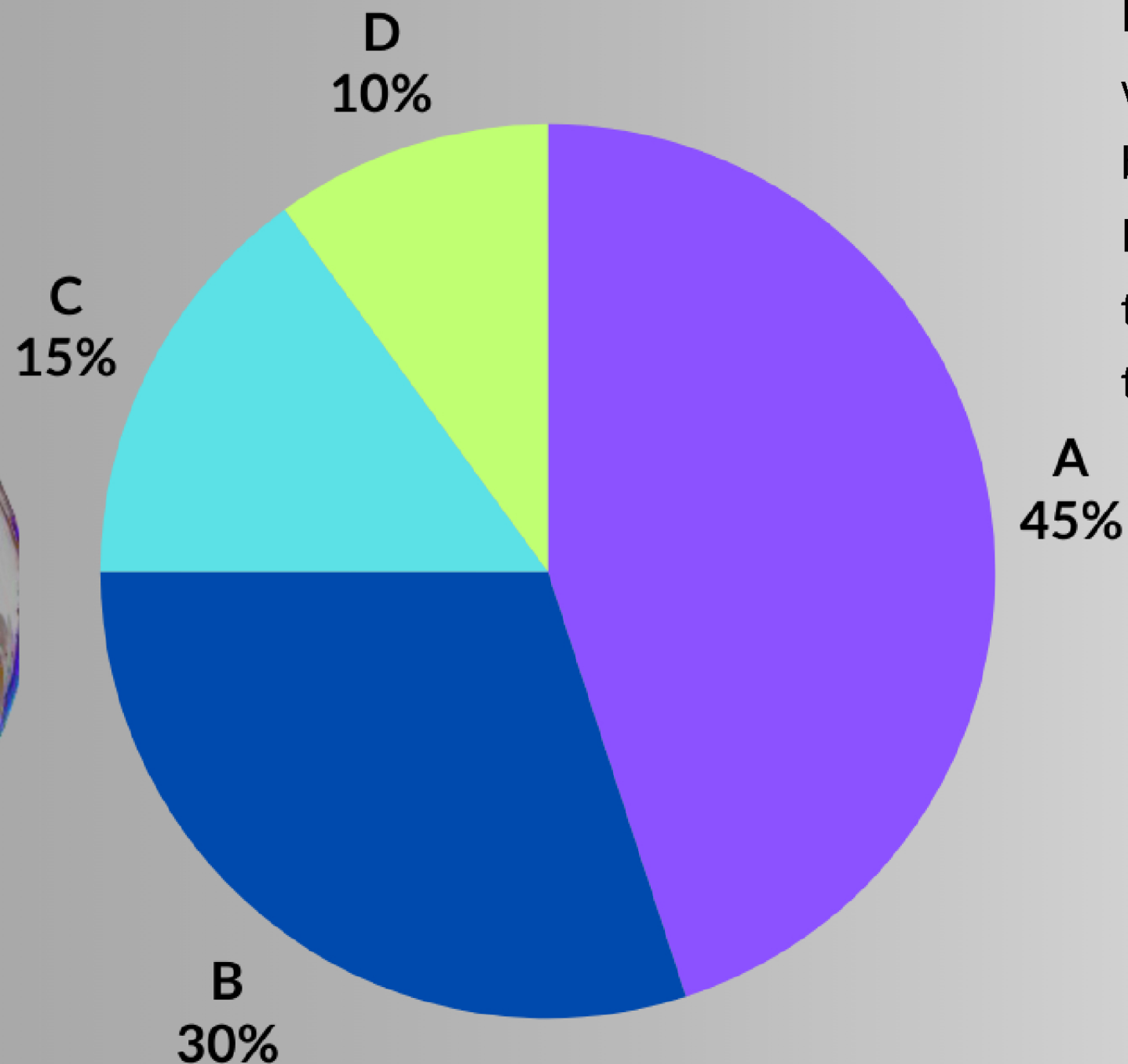


The VR market is steadily diversifying. Gaming and Entertainment (45%) remain the leading sector, driven by the demand for immersive experiences and platforms such as Meta Quest, with 36% of game developers creating titles for VR platforms (*Source: Alsop T., 2023*).

Healthcare and Education (30%) are rapidly adopting VR, transforming therapy, rehabilitation, and interactive learning environments, with spending predicted to reach £24.6 billion by 2026 (*Source: Grand View Research, 2025*).

Industrial and Training Applications (15%) are using VR for simulations and workforce skill development, helping organisations streamline operations and boost efficiency (*Source: Research and Markets, 2025*).

Lastly, Other Sectors (10%), including retail and real estate, are leveraging VR technologies for immersive experiences such as virtual shopping and property tours (*Source: Smith et al., 2025*).



A. 45% Gaming and Entertainment:

B. 30% Healthcare and Education

C. 20% Industrial and Training Applications

D. 10 % Other Sectors



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# THANK YOU

for your time and attention

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