WHITE PAPER | VESA DISPLAYPORT ADAPTIVE-SYNC

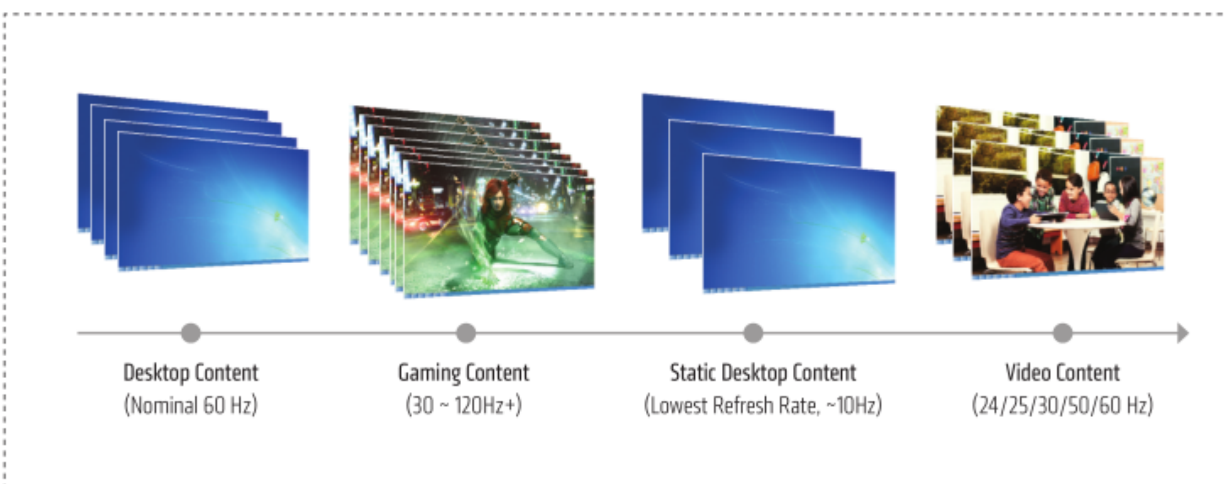
Written by Syed Athar Hussain, Display Domain Architect, AMD and Shane Parfitt, Technology Manager Display Domain, AMD

INTRODUCTION

For many years, the display industry has operated with the ubiquitous understanding that displays run at a fixed refresh rate (eg. 60 Hz). This is in contrast with the fact that there are many types of content that can be sent to a display, each with its own unique, and sometimes varying, frame rate. When the display refresh rate is not synchronized to the content frame rate, the user can experience undesirable effects such as tearing and stutter. For mobile applications (such as table and notebook PC), unnecessarily high display refresh rates for static and video content can increase power draw and reduce battery life. These factors have given rise to the need for a technology that allows the refresh rate of the display to adapt to the frame rate of the content, in a way that is seamless to the end user. The Video Electronics Standards Association (VESA®) has developed an industry standard that enables interoperable variable refresh rate capabilities over DisplayPort and Embedded DisplayPort interfaces, known as "Adaptive-Sync". This document discusses the use cases and benefits that this technology can provide.

Figure 1 shows how a variable refresh rate scheme can allow a graphics source to dynamically adjust display refresh rate based on typical content frame rates for power efficient, virtually stutter-free, and low-latency display update.

Figure 1: Content Adaptive Display Refresh

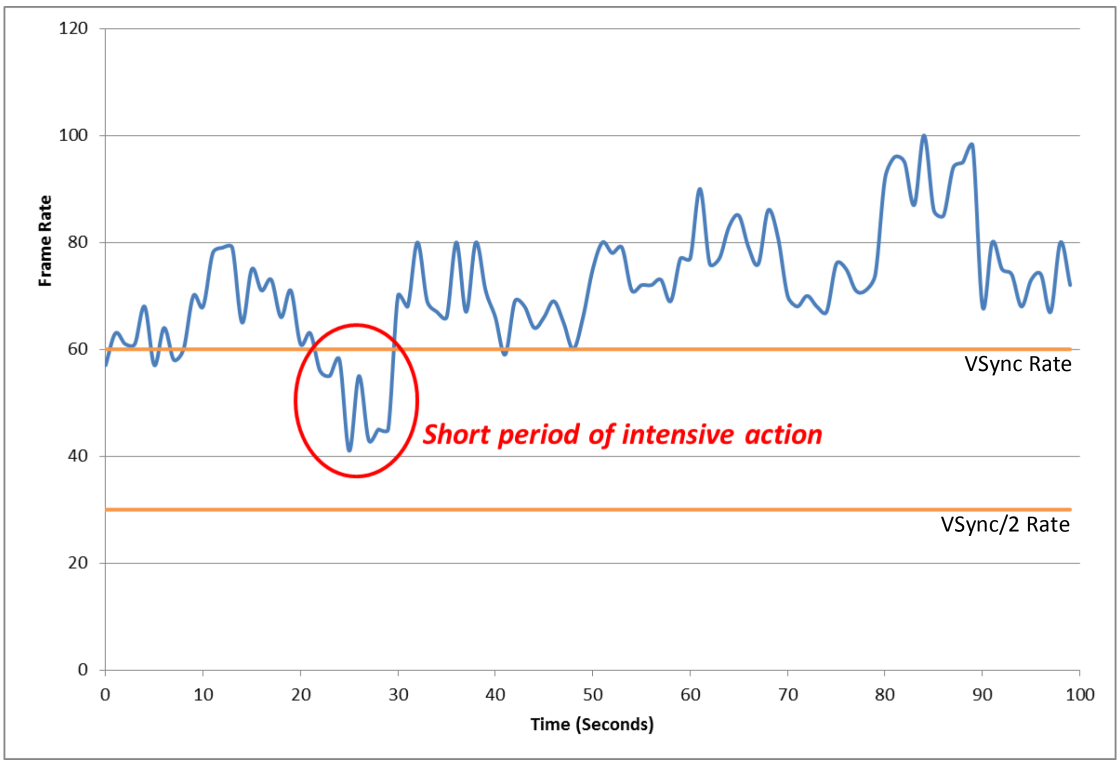


DisplayPort ADAPTIVE-SYNC USE CASES

GAMING

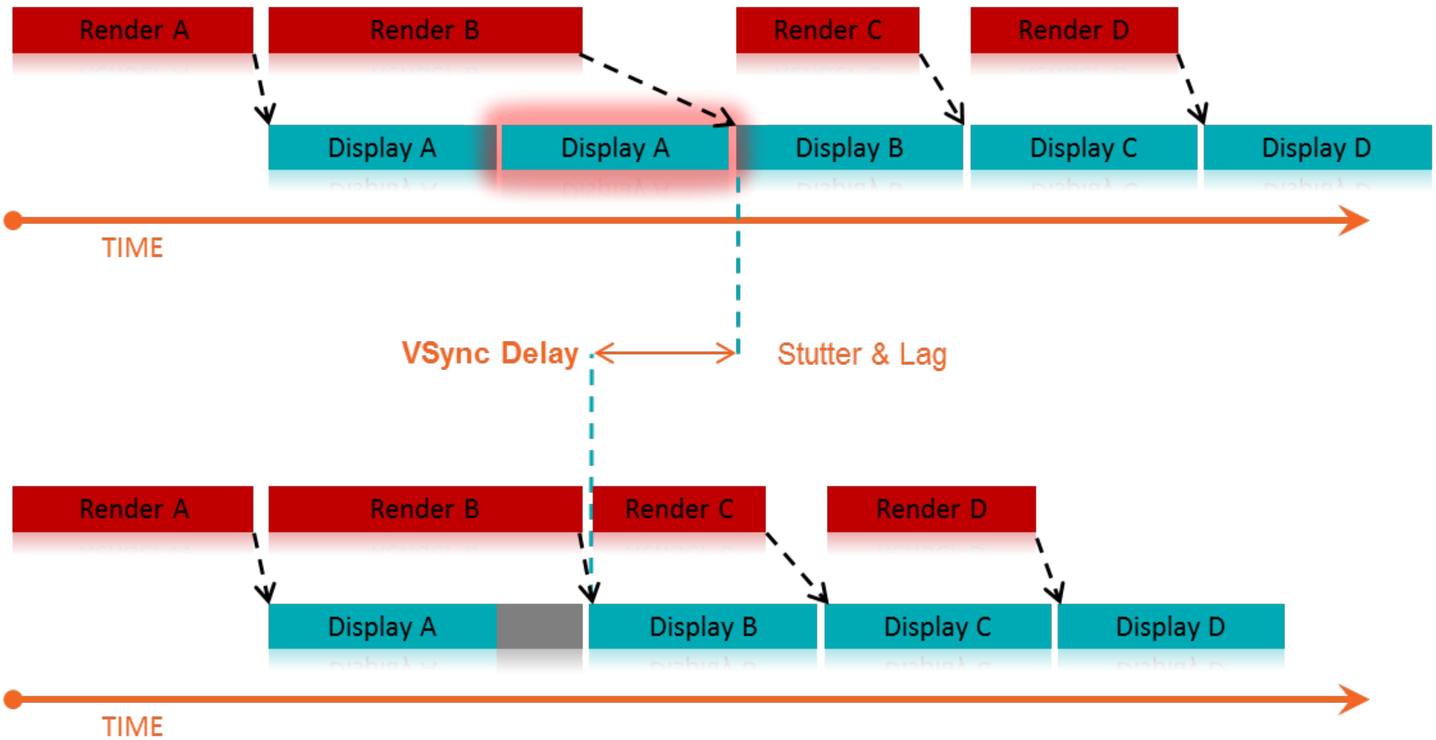
Variable refresh rate technologies have obvious benefits for the gaming experience. In a typical video game, the rendering frame rate varies widely over time due to the diversity of GPU computational work required throughout the game (illustrated in Figure 2). Some scenes with little detail or few effects will render quickly at a high frame rate, while other scenes with more detailed environments, which may include a greater number of effects (such as explosions, smoke, etc),can take a longer time to render. This variance in frame rate has traditionally presented gamers with a trade-off with respect to how they choose to refresh the display, such choosing to enable the 'VSync' setting in their application.

Figure 2: Illustration of framerate over time in a typical video game



With 'VSync' enabled, the display buffer is only refreshed during the vertical blanking interval between frames, so that a full frame is always displayed and no tearing is visible. This is great if the game's rendering frame rate is higher than the refresh rate of the display. If the game's frame rate drops below the refresh rate of the display (eg. during a short period of intensive action), then the new frame will not be ready in time for the display's blanking interval, and the previous frame is repeated on the display. This is illustrated in Figure 3 as Render Frame B took so long to render, that Frame A had to be repeated. This effect manifests itself as stutter and lag to the end user. The alternative for the gamer is to disable VSync, which virtually eliminates stutter and lag, but can produce visible tearing, especially during scenes with fast movement.

Figure 3: Frame analysis of traditional VSync vs Adaptive-Sync



Variable refresh rate technologies such as DisplayPort Adaptive-Sync address these issues by providing a mechanism that allows the display refresh rate to change dynamically in response to the rendering frame rate of the game. In the case illustrated in Figure 2, the display will wait until Render Frame B is finished and ready before updating the display. This helps ensure that a frame is almost always displayed as soon as possible, avoiding lag. It also helps ensure that frames do not need to be repeated within the refresh rate range of the display, avoiding stutter. The display refresh rate is synchronized to the rendering frame rate, which helps avoid the issue of tearing associated with VSync-off. DisplayPort Adaptive-Sync provides the ideal solution for smooth gameplay with decreased lag and virtually no tearing.

VIDEO PLAYBACK

DisplayPort Adaptive-Sync may also be applied to use cases other than gaming. For example, it can be used to enable the essentially seamless playback of video at almost any frame rate (eg. 23.98, 24, 25, 29.97, 30, 48, 50, 59.94, 60 fps). In the case of video content with a fixed frame rate, the refresh rate is set up to match the frame rate of the video content. DisplayPort Adaptive-Sync can provide virtually judder -free playback at almost any video frame rate without the need for costly Frame Rate Conversion (FRC) post-processing. This can also help reduce power consumption during video playback.

SYSTEM POWER SAVINGS

Variable refresh rate technology has been available to Notebook PC makers for quite some time as a system power saving feature for embedded notebook panels. This is already a capability of the Embedded DisplayPort interface, for example. When the system enters a static screen state (no new content), the refresh rate of the display is lowered to the minimum rate that it can support, to save power. The transition between refresh rates is invisible to the end user, and it comes at a low cost to PC makers since no additional hardware is required to enable this feature.

CONCLUSION

In summary, VESA's DisplayPort Adaptive-Sync standard can be used to create products with variable refresh rate capabilities that offer a number of benefits:

- Dynamically adapts the display refresh rate to a variable gaming content render rate for low latency and a smooth, virtually stutter-free gaming experience.
- Dynamically adapts the display refresh rate to fixed video content frame rate for a power efficient and virtually stutter-free video playback experience.
- Helps improve battery life by reducing the refresh rate of the panel when the screen is static
- Ensures that the transition between refresh rate is seamless and undetectable to the user