Integer Scaling Support on Intel® Graphics

July 2019

Revision 1.0

What is pure integer scaling (IS)?

Integer scaling (IS) is a type of nearest-neighbor upscaling technique that simply scales up the existing pixels by an integer (i.e. whole number) multiplier. More generally, nearest-neighbor interpolation works by filling in the missing color values in the up-scaled image with that of the co-ordinate mapped nearest source pixel value. Both IS and NN preserve the clarity of the original image. By contrast, traditional upscaling algorithms, such as bilinear or bicubic interpolation, result in blurry upscaled images as they employ interpolation techniques designed to smooth out the transition from one pixel to another. Integer scaling is, therefore, particularly useful for pixel art games, which rely on sharp, blocky images to deliver their distinctive look.

What is Intel implementing on Gen11 in the late August driver release?

We will be providing options to enable both integer scaling (IS) as well as nearest-neighbor (NN)-based scaling in the Intel® Graphics Command Center. Both options are provided as some users might prefer NN to IS, as the former can – depending on the OS and display panel resolution – yield greater overall display utilization. This is described in greater detail later in the document.

In what scenarios can I get full-screen pure integer scaling?

When the dimensions of the scaled image are the same integer multiple of the original image. For example, scaling a game with a resolution of 1280 x 720 on a panel with a resolution of 3840 x 2160 should yield pure integer scaling since the dimensions of the panel represent those of the source image multiplied by three, respectively.

In what scenarios will I not get full-screen pure integer scaling?

When the resolution of the display panel has a different aspect ratio from that of the original image or, in situations where the aspect ratios of the source image and the panel are the same but the dimensions of the display do not represent integer multiples of the source image. In these situations, users can expect a black border around the image.

- Example 1: Scaling a game running at a resolution of 640x480 (4:3 aspect ratio) on a 3840x2160 (16:9 aspect ratio) panel. In this case, IS will not happen by default as the full height of the display panel would not be used. In this case, the user would need to force IS to yield an image with a resolution of 2560 x 1920 and black borders around it to fill the remaining space. Without forcing IS, the driver will scale the image to 2880 x 2160, putting borders on just the sides.

- Example 2: Scaling a game running at a resolution of 800 x 600 on a 1920 x 1080 display. In this case, Integer Scaling (IS) is not possible because scaling the height of the image by any integer greater than 1 would yield an image with a height greater than that of the display. As a result, the game would simply be rendered at the original resolution and centered on the panel surrounded by black bars.

What are the OS challenges with integer scaling?
Integer scaling introduces several challenges related to the OS composition model of multi-plane overlay, cursor coordinate mapping and touch interaction, since the OS is unaware of such a scaling option[3]. We therefore kept the design of this implementation simple to solve issues other than touch, and believe that touch will not be an issue for gamers looking to play the kinds of games that benefit from NN scaling and IS. Moreover, most external monitors – which some gamers will connect to their systems to enjoy the benefits of larger screens – don't support touch input.

Will Intel implement pure integer scaling with borders?
Yes, the driver slated to be released in late August will provide users with the option to force integer scaling. The IS option will restrict scaling of game images to the greatest possible integer multiplier. The remaining screen area will be occupied by a black border, as mentioned in some of the previous examples.

Why does Intel want to provide nearest-neighbor option in addition to integer scaling?
Nearest-neighbor can provide the same scaled image without employing an interpolation algorithm during the scaling process. This will ensure that image sharpness is retained while allowing users to enjoy optimal utilization of their display area. Integer scaling – depending on the resolution of the panel as well as the OS scaling options – might result in a smaller viewable area than would be possible with nearest-neighbor scaling.

For instance, integer scaling of a 1024 x 768 image on a 3840 x 2160 panel will yield a scaled resolution of 2048 x 1536, but nearest-neighbor scaling would enable a scaled resolution of 2880x2160 and, ultimately, 98% more usable screen space than with integer scaling.

How can I enable this feature once it's available?
Enable the new scaling option that supports integer scaling or nearest-neighbor in Intel® Graphics Command Center. Keep in mind that "Maintain Aspect Scaling" will yield the best experience when NN-mode is enabled.
We will provide users with options to enable either integer scaling or nearest-neighbor scaling in Intel® Graphics Command Center. (Note: To ensure that these features are accessible to as many users as possible, we are working to finalize the naming for the integer scaling and nearest-neighbor scaling features in Intel® Graphics Command Center – feel free to post your suggestions!)

Run the game in exclusive full screen mode. The game will do a mode set to the resolution to which it is being rendered. That will get scaled based on your NN/IS options.

Will there be any performance or power impact?
No, since the feature is using our fixed function display engine.

Minimum resolution supported
The minimum supported OS resolution is 640x480. Enumerating resolutions lower than this generally results in longer system boot times as the OS enumeration time rises with each additional resolution.

Algorithm used for typical low resolutions

1920x1080 panel

OS Resolution	Nearest Neighbor	Integer Scaling	Final resolution
640 x 480	x	x	IS: Image scaled to 1280 x 960 NN: Scaled to 1440 x 1080
800 x 600	x		Integer scaling not possible NN: Image scaled to 1440 x 1080
1024 x 768	x		Integer scaling not possible NN: Image scaled to 1440 x 1080
1280 x 720	x		Integer scaling not possible NN: Image scaled to 1920 x 1080
1280 x 1024	x		Integer scaling not possible NN: Image scaled to 1350 x 1080

2560x1440 panel

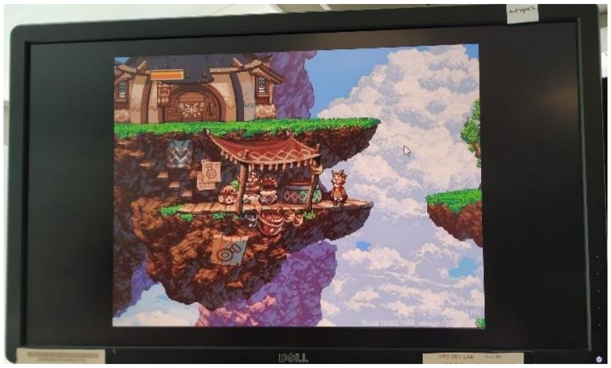
OS Resolution	Nearest Neighbor	Integer Scaling	Final resolution
640 x 480	x	x	IS: Image scaled to 1920 x 1440 NN: Scaled to 1920 x 1440
800 x 600	x	x	IS: Image scaled to 1600 x 1200 NN: Scaled to 1920 x 1440
1024 x 768	x		Integer scaling not possible NN: Scaled to 1920 x 1440
1280 x 720	x	x	Image scaled to 2560 x 1440
1280 x 1024	x		Integer scaling not possible NN: Image scaled to 1800 x 1440

3840x2160 panel

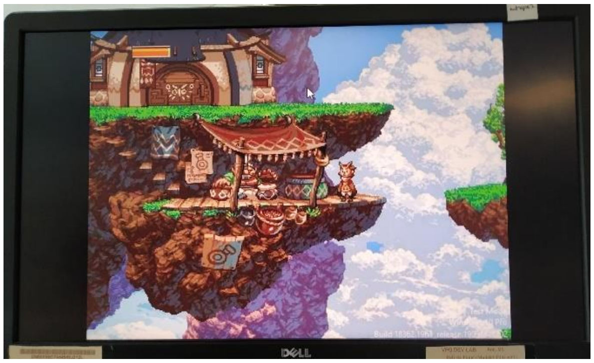
OS Resolution	Nearest Neighbor	Integer Scaling	Final resolution
640 x 480	x	x	IS: Image scaled to 2560 x 1920 NN: Scaled to 2880 x 2160
800 x 600	x	x	IS: Image scaled to 2400 x 1800 NN: Scaled to 2880 x 2160
1024 x 768	x	x	IS: Image scaled to 2048 x 1536 NN: Scaled to 2880 x 2160
1280 x 720	x	x	Image scaled to 3840 x 2160
1280 x 1024	x	x	IS: Image scaled to 2560 x 2048 NN: Image scaled to 2700 x 2160

2048 x 1152	x		Integer Scaling not possible NN: Image scaled to 3840 x 2160

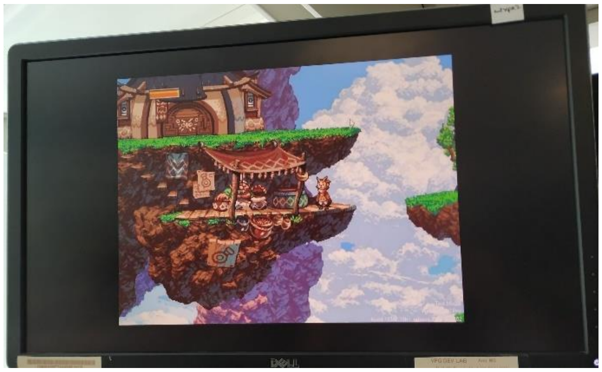
Examples below to illustrate NN Scaling (IS and non-IS) on a 4K (3840 x 2160 monitor)



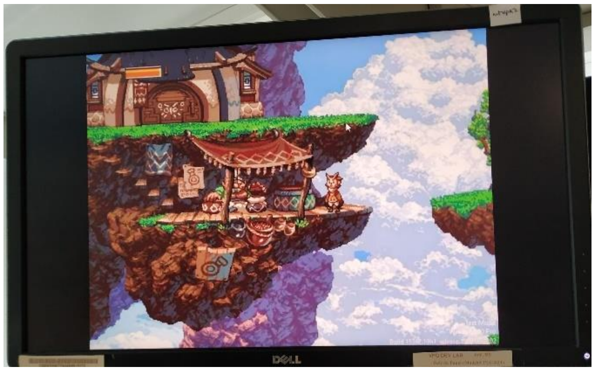
NN - IS scaling:
640 x 480 scaled to 2560 x 1920



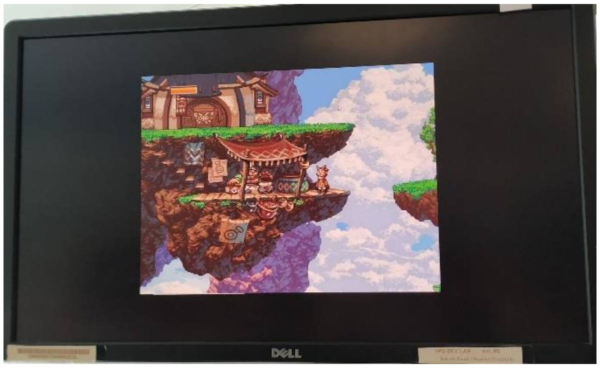
NN – non-IS scaling:
640 x 480 scaled to 2880 x 2160

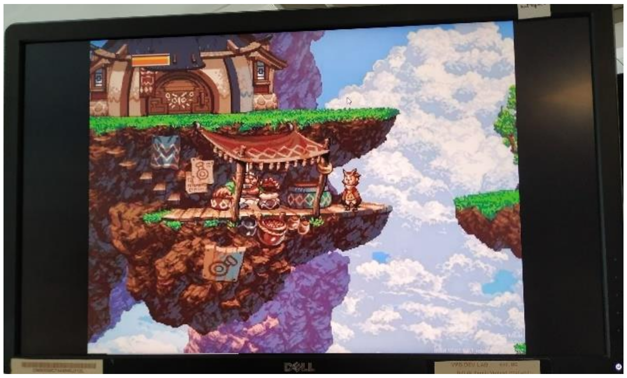


NN –IS scaling:
800 x 600 scaled to 2400 x 1800



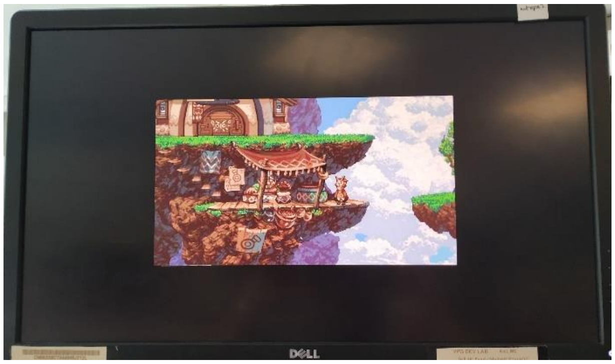
NN – non-IS scaling:
800 x 600 scaled to 2880 x 2160

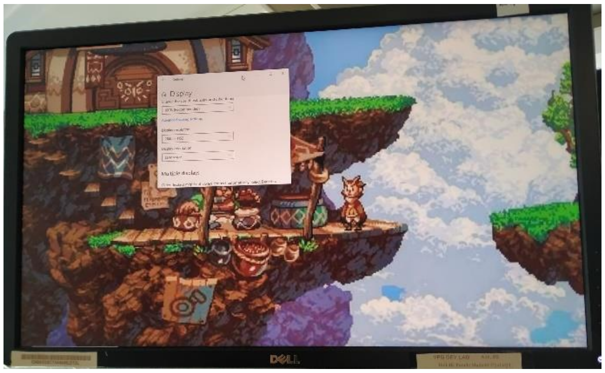




NN –IS scaling:
1024 x 768 scaled to 2048 x 1536

NN – non-IS scaling:
1024 x 768 scaled to 2880 x 2160





NN –IS scaling:
2048 x 1152 cannot be scaled with IS mode

NN – non-IS scaling:
2048 x 1152 scaled to 3840 x 2160

Emulated gaming scenarios
There are scenarios where users try to play games with various emulators. Most often in such scenarios the emulator handles scaling on their own and this cannot be solved using Intel's scaling implementation.

Windowed gaming scenarios
There could be scenarios where a game comes up in windowed mode over desktop. Here scaling, if required, will be done by either game or OS composition manager. Here it's difficult to guarantee whether Intel's scaling will get used or not from an IHV perspective. Users are advised to use full screen options to get the best possible scalar option. For most of the games Alt+Enter key combination will toggle between windowed and full screen option.

Will there be any impact to power & performance?
Both scaling options will be implemented using the fixed display pipeline, which means Both scaling options will be implemented using the fixed display pipeline resulting in no impact to system power or performance of the game.

[1] *Game image used for example purpose only*

[2] *Multi-plane overlay: A feature supported by Windows WDDM 1.3 & beyond for optimizing desktop composition activities. Refer* https://docs.microsoft.com/en-us/windows-hardware/drivers/display/multiplane-overlay-support

[3] *Windows desktop scaling:* https://docs.microsoft.com/en-us/windows-hardware/drivers/display/scaling-the-desktop-image