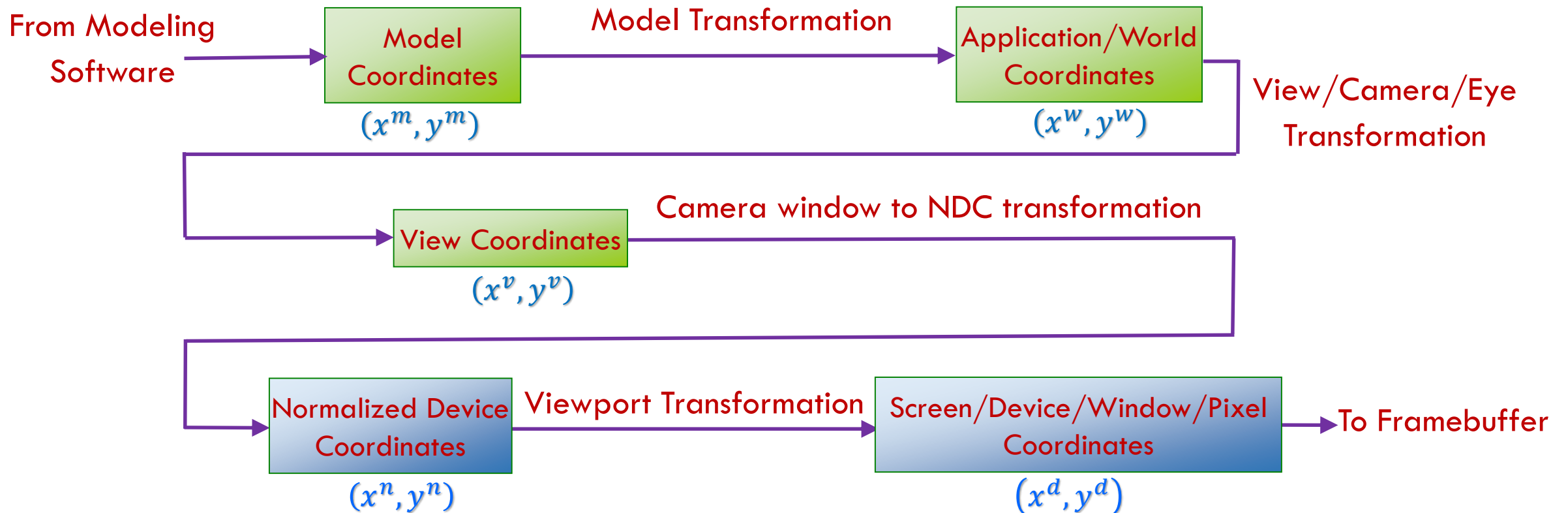# Introduction to Computer Graphics
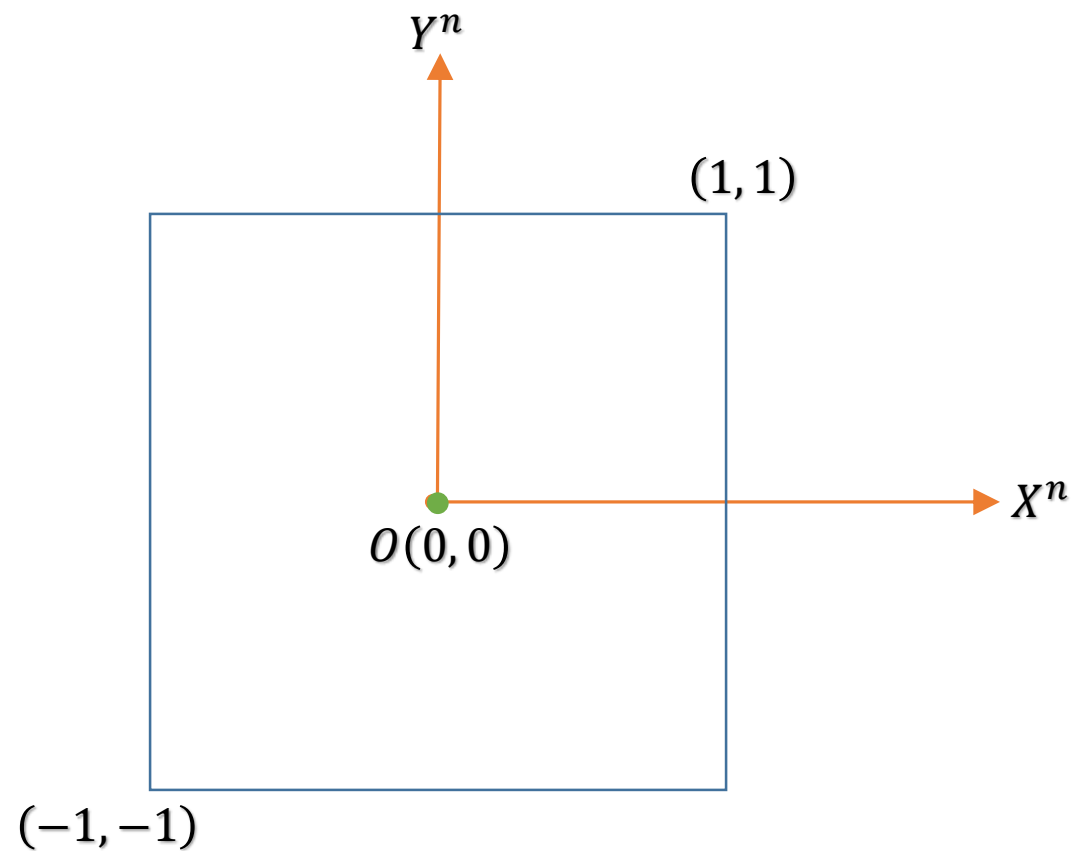
Viewport Transformation

Prasanna Ghali

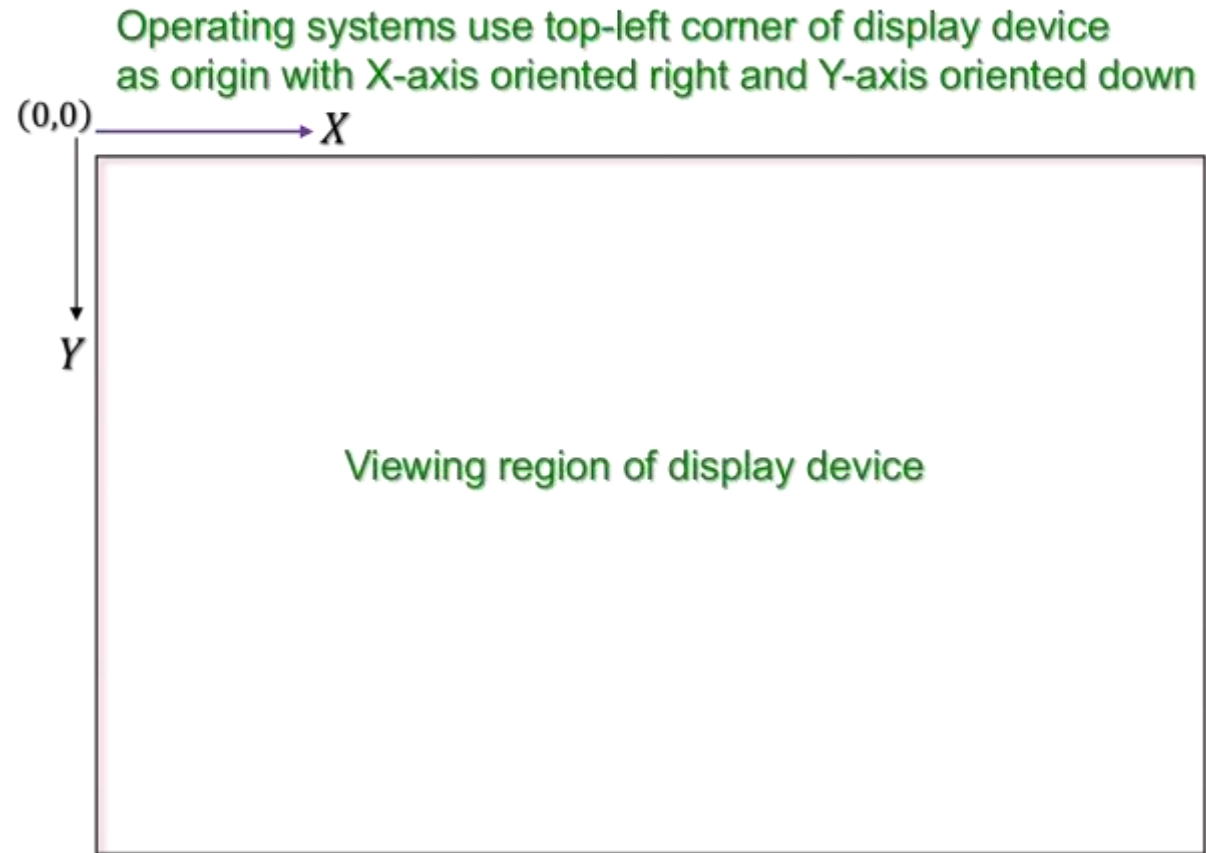# 2D Rendering Pipe: Coordinate Systems

- Rendering pipeline for 2D applications: different coordinate systems that 2D objects [and their primitives] must transition thro' in rendering pipeline
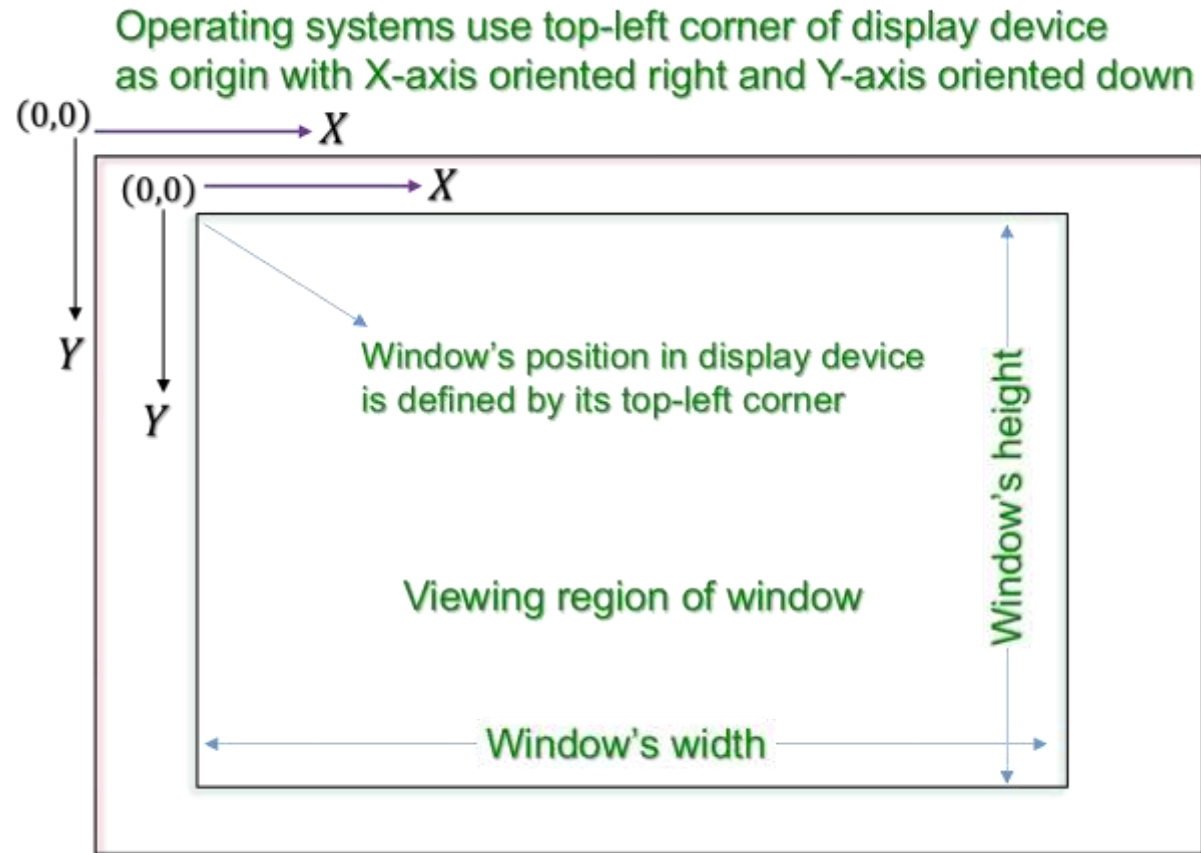
From Modeling Software → **Model Coordinates** (x^m, y^m)

Model Transformation →

Application/World Coordinates (x^w, y^w)

View/Camera/Eye Transformation

View Coordinates (x^v, y^v)

Camera window to NDC transformation

Normalized Device Coordinates (x^n, y^n)

Viewport Transformation →

Screen/Device/Window/Pixel Coordinates (x^d, y^d)

→ To Framebuffer

Normalized Device Coordinates

Display Coordinate System

Operating systems use top-left corner of display device as origin with X-axis oriented right and Y-axis oriented down

(0,0) ——————→ X

Y

Viewing region of display device

Window in Display Device

Operating systems use top-left corner of display device as origin with X-axis oriented right and Y-axis oriented down

Window's position in display device is defined by its top-left corner
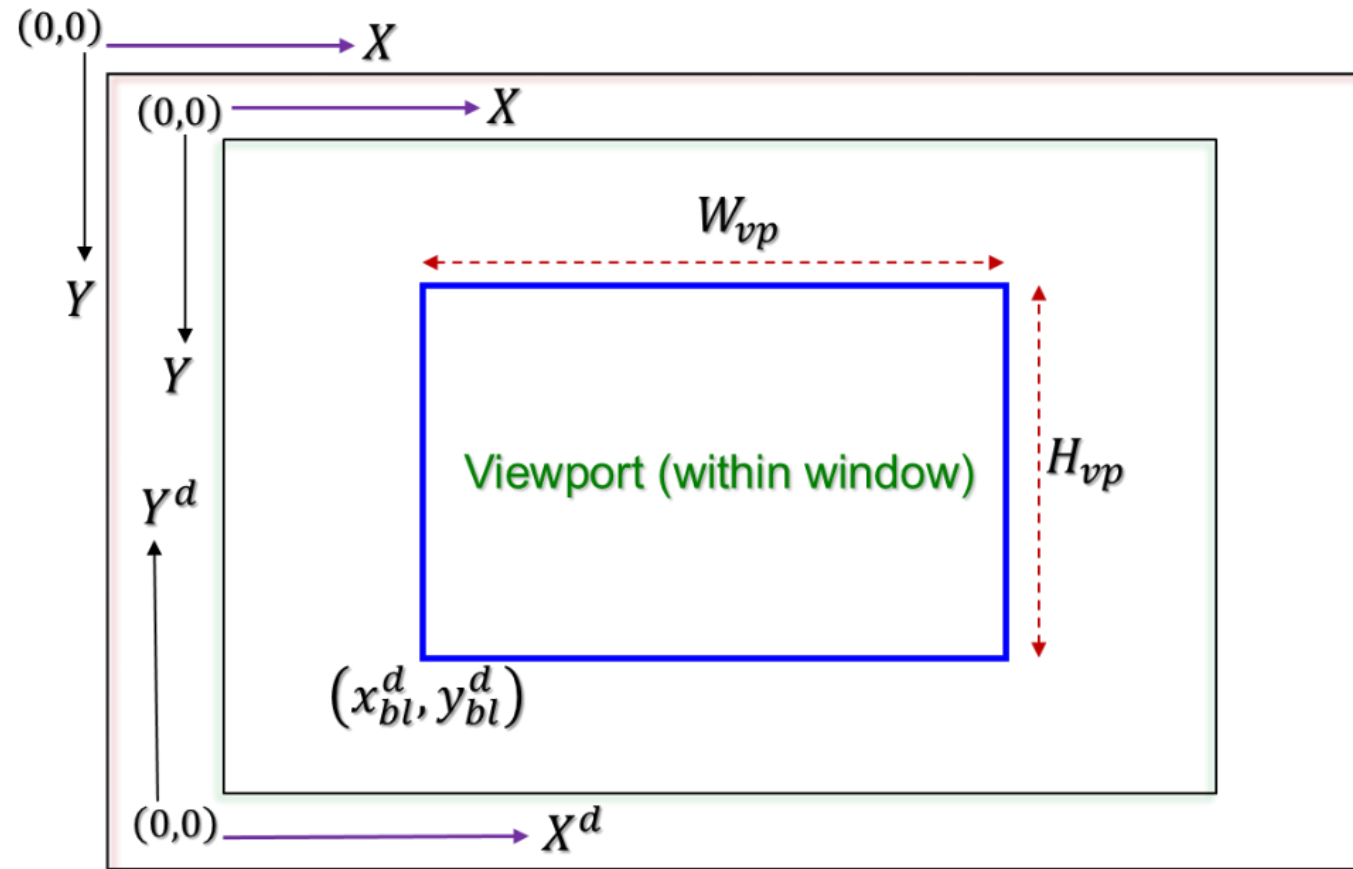
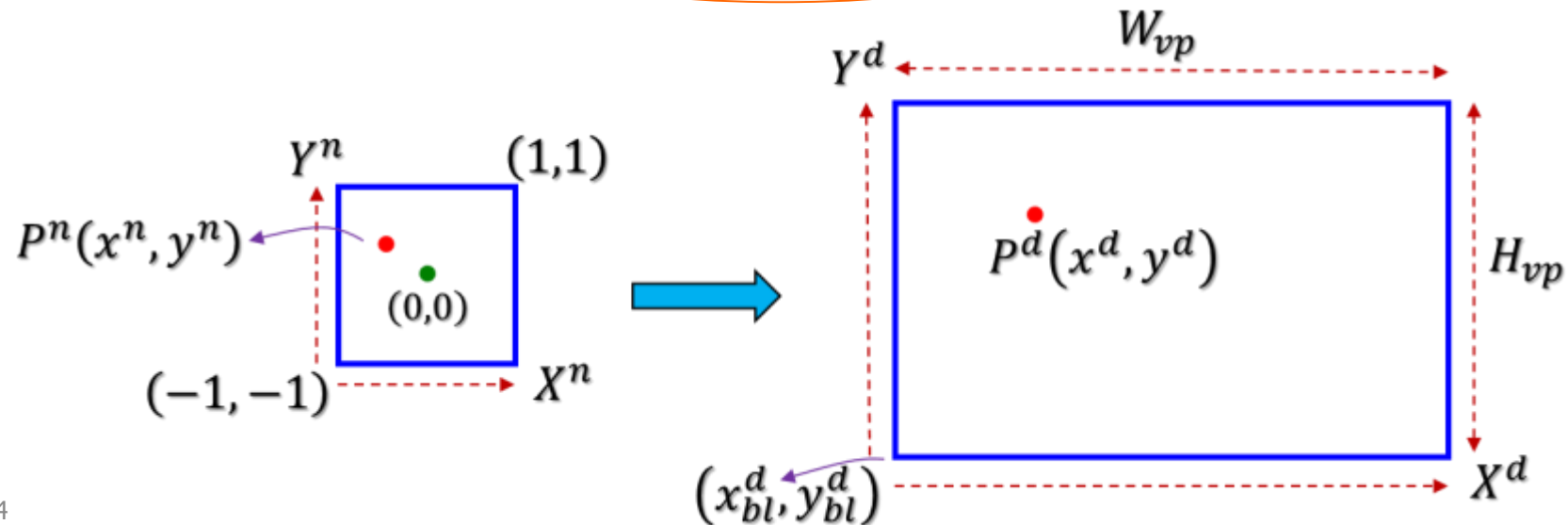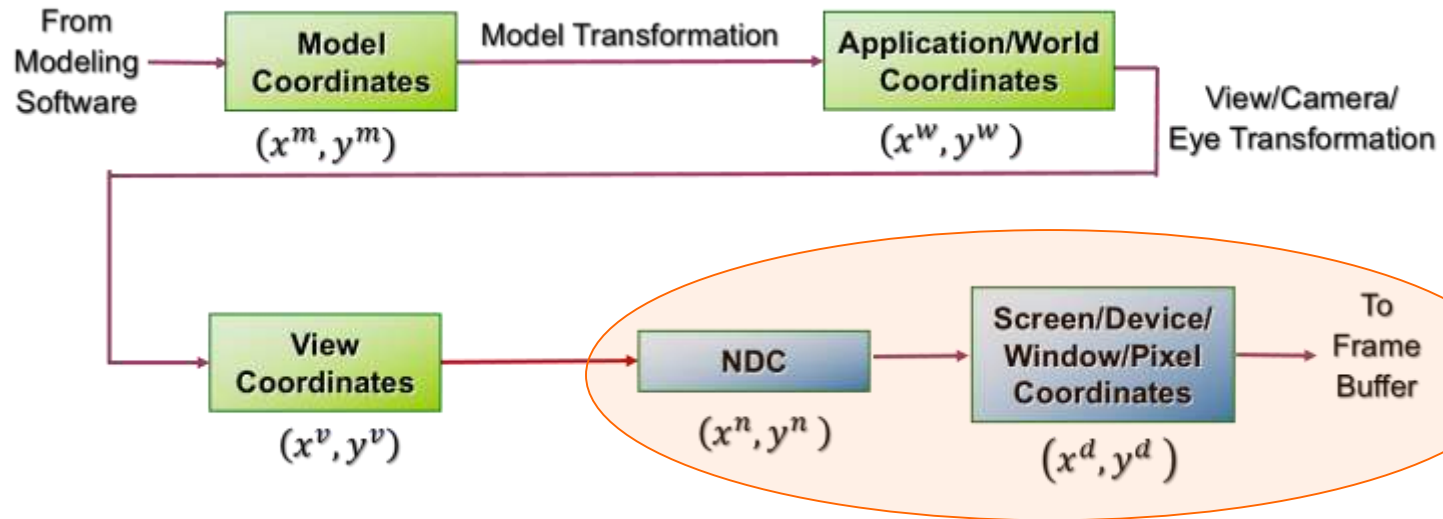Viewing region of window

Window's height

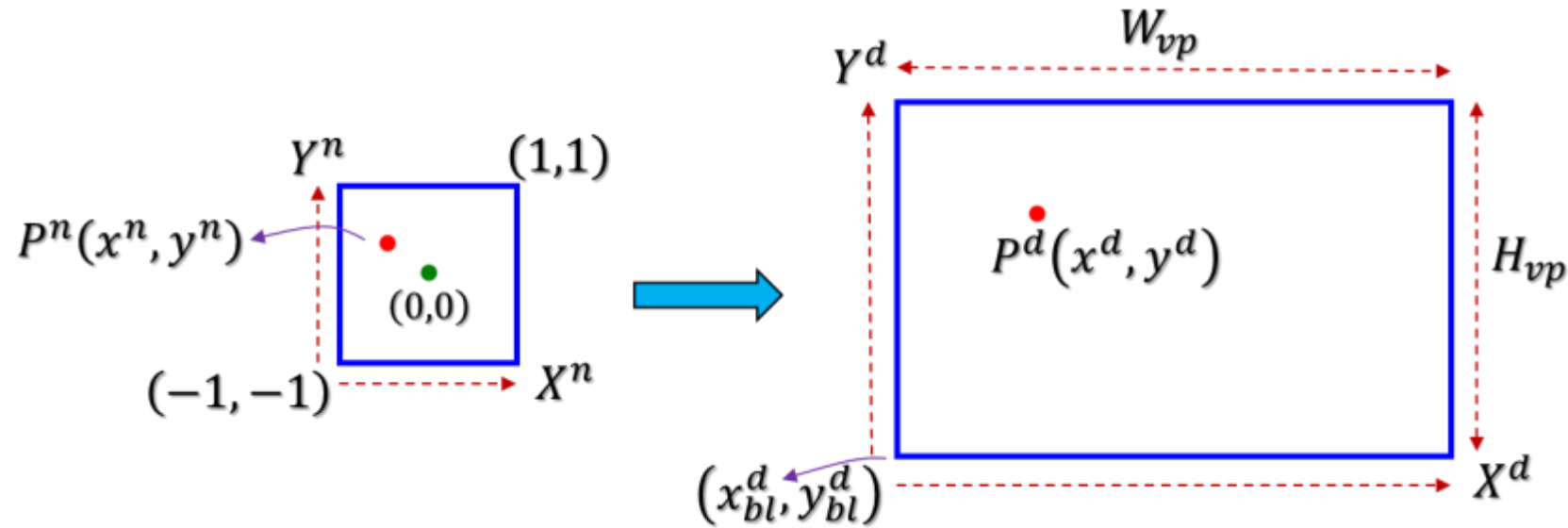Window's width

OpenGL Window Coordinate System
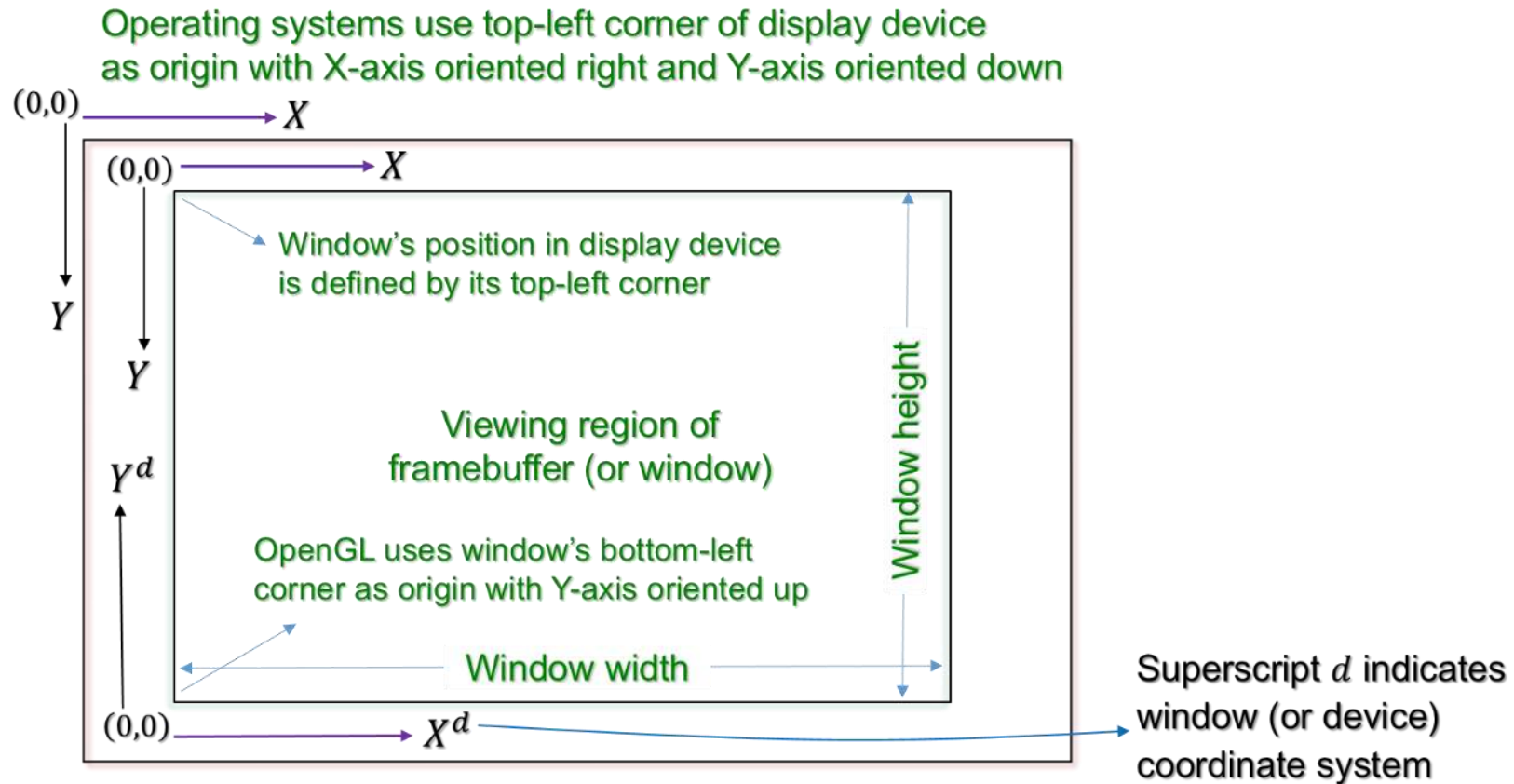
OpenGL Viewport in Window Coordinate System

Viewport Transformation

Viewport Transformation Matrix

$$\mathbf{M}_{viewport} = \begin{bmatrix} \dfrac{W_{vp}}{2} & 0 & x_{bl}^d + \dfrac{W_{vp}}{2} \\[2em] 0 & \dfrac{H_{vp}}{2} & y_{bl}^d + \dfrac{H_{vp}}{2} \\[1em] 0 & 0 & 1 \end{bmatrix}$$