04 - The Game Loop and Game Ticks

CS 3160 - Game Programming
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The Game Loop

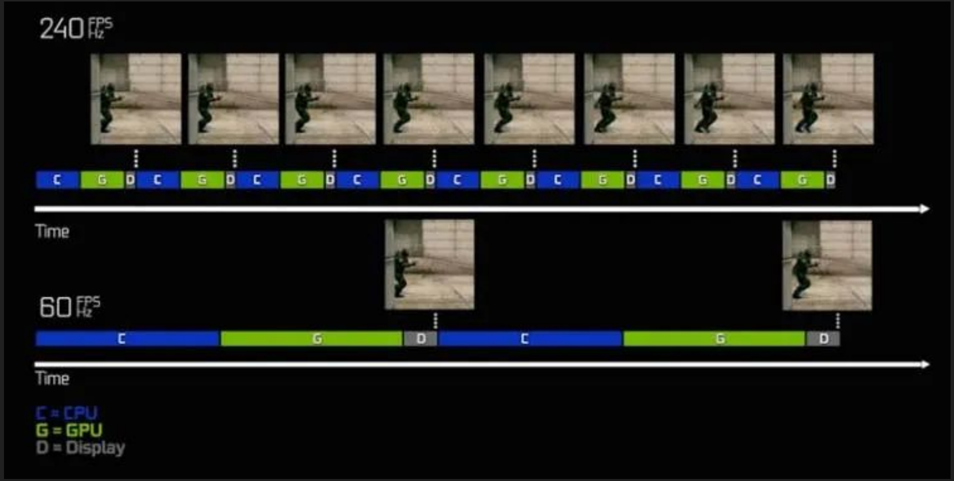
- Games are just a massive infinite loop, this is called the Game Loop
- The Game Loop can be made up of many other loops:
    - Variable Update Loop (Frame Rate)
    - Fixed Update Loop (Game/Physics Ticks) (Physics Rate)
    - Network Loop (Tick Rate)
        - *Tick Rate* (network) not to be confused with *Game Ticks* (physics)
    - Possibly more?

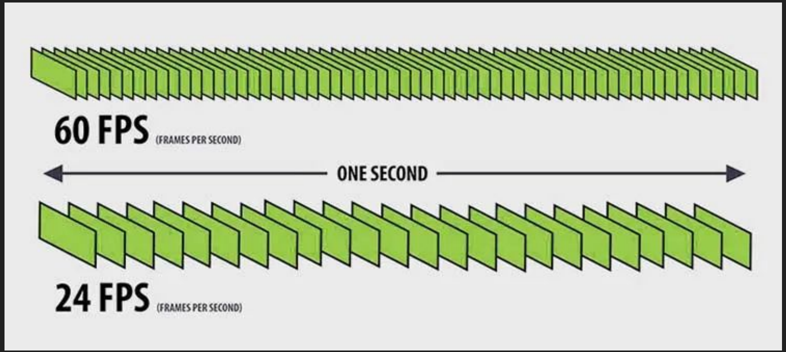
What Happens in the Game Loop

- The game loop could run these in any order, but this order is probably best
  1. Handle the player’s input
  2. Update logic
  3. Update physics (CPU intensive)
  4. Render the individual frame to the display (GPU intensive)
  5. (Optional) Wait for some time to fix the frame rate to wait for vsync
- You want the above loop to run as fast as possible

What Happens in the Game Loop

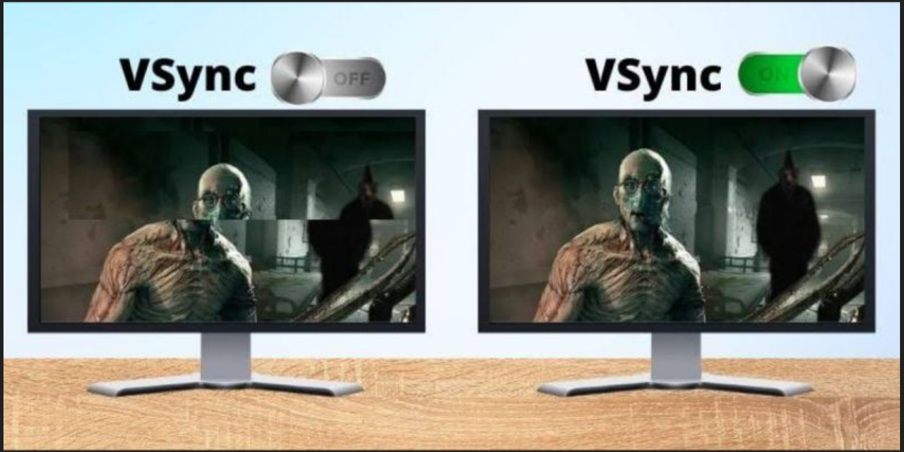
- Displaying the game on your monitor happens 10’s to 100’s of times per second
- This is not an easy thing to do and requires a lot of hardware working together harmoniously

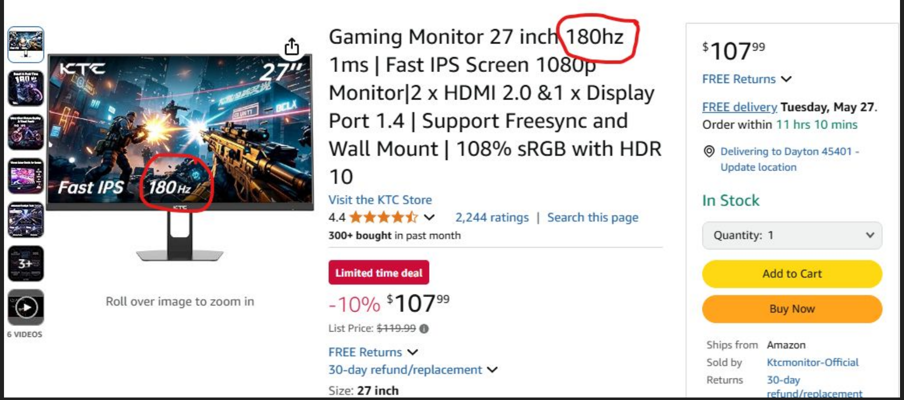




Waiting for VSync

- If you game renders frames (FPS) faster than your monitor (refresh rate) can accept these frames you can get screen tearing
  - Screen tearing is a display issue
  - See: https://www.youtube.com/watch?v=jVAFuUAKPMc
- To solve this issue, enable vsync, which forces your game to never exceed the monitor’s refresh rate





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Variable Update Loop

- Games have a variable update loop that tries to display the game on your screen as fast as possible (frame rate)
    - Called “Update” in Unity
    - It takes your CPU and your GPU time to run your game
    - In very intense moments, your game can run at a slower rate
    - In very light moments, your game can run at a faster rate
    - As a game programmer you should try your best to achieve a constant or smooth variable update loop
        - Nobody likes a game to stutter or run slow in the heat of a massive battle or important moment!
        - https://www.youtube.com/watch?v=ESLdzYs8Bj4
        - https://www.youtube.com/watch?v=uQQ3eg4-ZWk

Physics Update (Fixed Update)

- Problem: Physics takes a lot of CPU power to calculate
- Problem: We want the physics of our game to be stable and reliable
- Solution: A separate loop (game ticks) that runs slower than our variable update that handles physics (physics rate)
    - Called “Fixed Update” in Unity
- If you run this separate loop much slower (like 30 times per second) then it’s not as much work for the CPU
- We do NOT want our physics to be dependent on our our frame rate (variable update loop)
    - https://www.youtube.com/watch?v=r4EHjFkVw-s

Physics Update (Fixed Update) (cont.)

- Problem: physics is running at a fixed 10 FPS and frame rate is at 100 FPS
    - The physics objects will appear to stutter or “snap” into place
- Solution: interpolation
- Interpolation means you approximate the position in between physics updates
    - This keeps the physics simulation running at a low FPS while maintaining smooth movement

Physics Update (Fixed Update) (cont.)

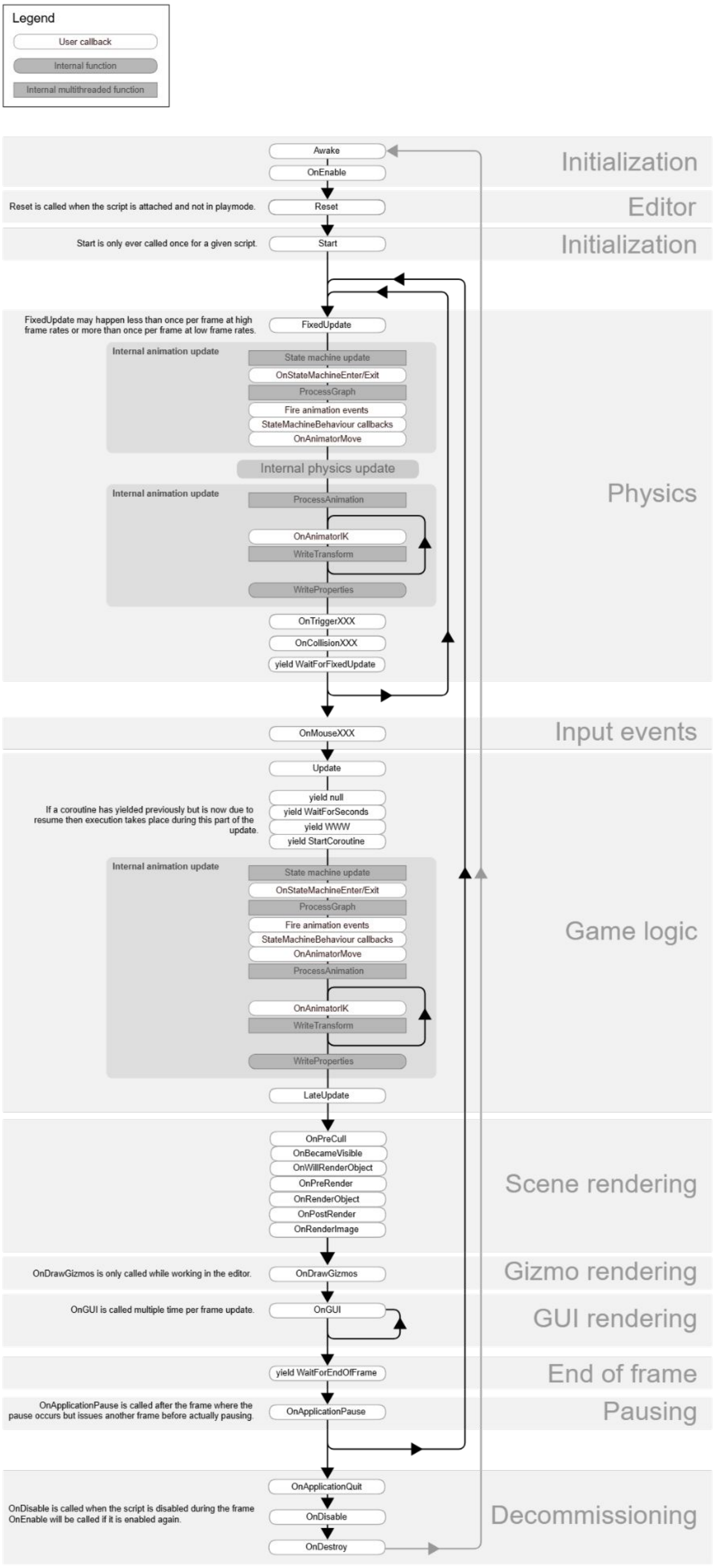
- Problem: on really low end hardware you might not run fast enough to run the physics fixed update in time
    - Example: on mobile your game might run at 20 FPS but your physics loop runs at 30 FPS
- Solution: have the game play out anyways but in slow motion (if necessary) as if it was actually 30 FPS

The Network Loop

- Multiplayer games have to communicate information between players, or the server and clients
- This is done using another loop that runs at a fixed rate called “Tick Rate”
    - This can also be tossed into the previously mentioned fixed update loop, instead of having another separate loop
- Example: Counter Strike servers and clients communicate at 64 tick rate in casual play and 128 tick rate in competitive
    - Every player sends their keyboard and mouse inputs to the server 64 times per second
    - The server sends game information back to the players 64 times per second

The Game Loop in Unity

- Unity’s game loop is very well documented and well structured:
    - https://docs.unity3d.com/Manual/execution-order.html
- Fixed Update always runs before Update
- If your game runs too slow, Fixed Update might run multiple times per rendered frame.
    - https://docs.unity3d.com/6000.1/Documentation/Manual/fixed-updates.html



Reset is called when the script is attached and not in playmode.

Start is only ever called once for a given script.

FixedUpdate may happen less than once per frame at high frame rates or more than once per frame at low frame rates.

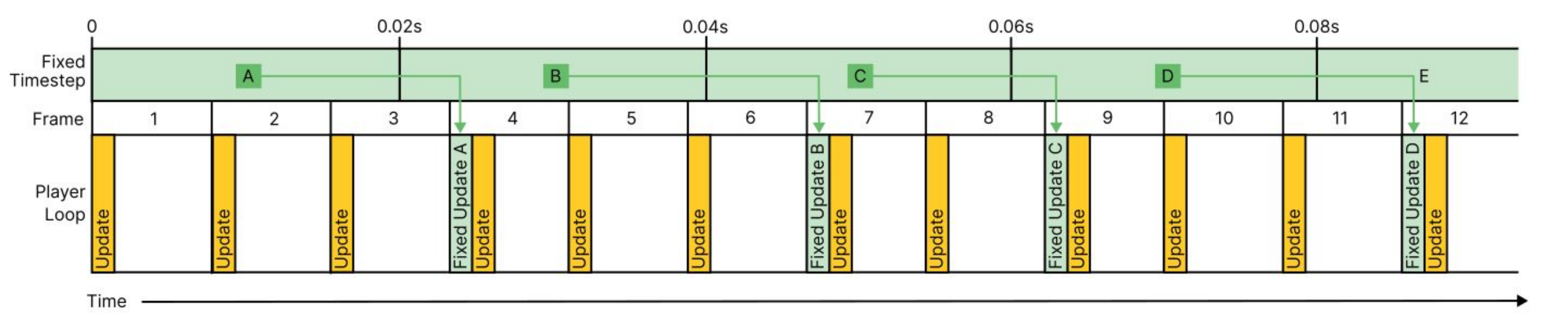
If a coroutine has yielded previously but is now due to resume then execution takes place during this part of the update.

OnDrawGizmos is only called while working in the editor.

OnGUI is called multiple time per frame update.

OnApplicationPause is called after the frame where the pause occurs but issues another frame before actually pausing.

OnDisable is called when the script is disabled during the frame OnEnable will be called if it is enabled again.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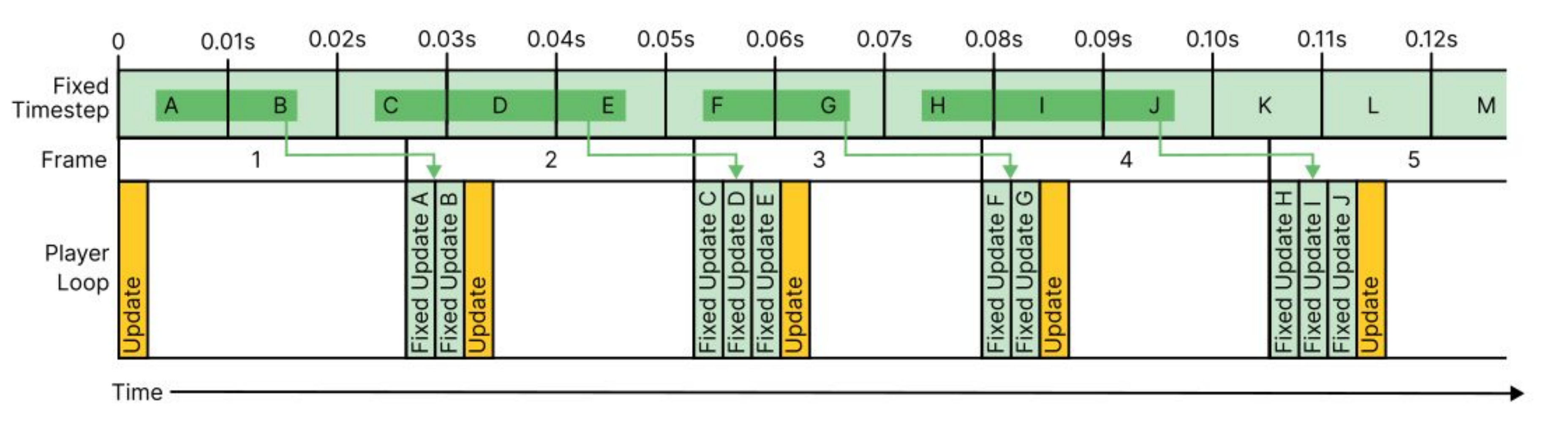
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