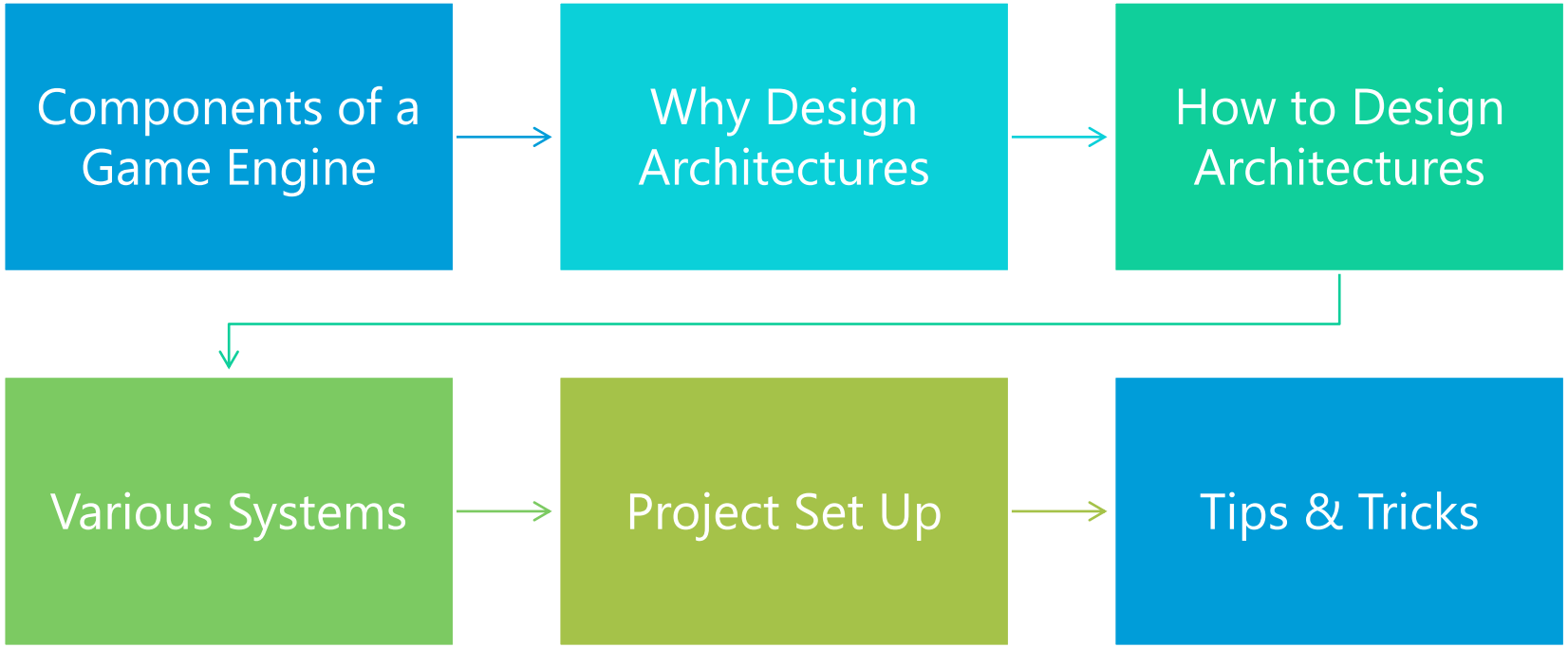
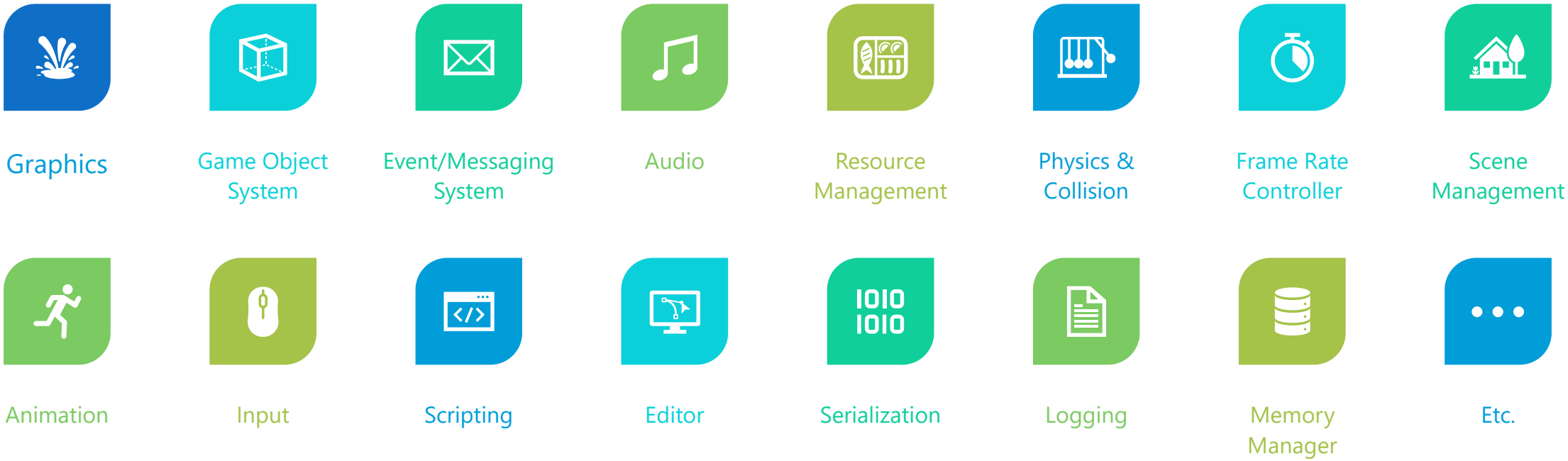
# Intro to Game Engine Architecture

Architecture Engine Club Summer 2023

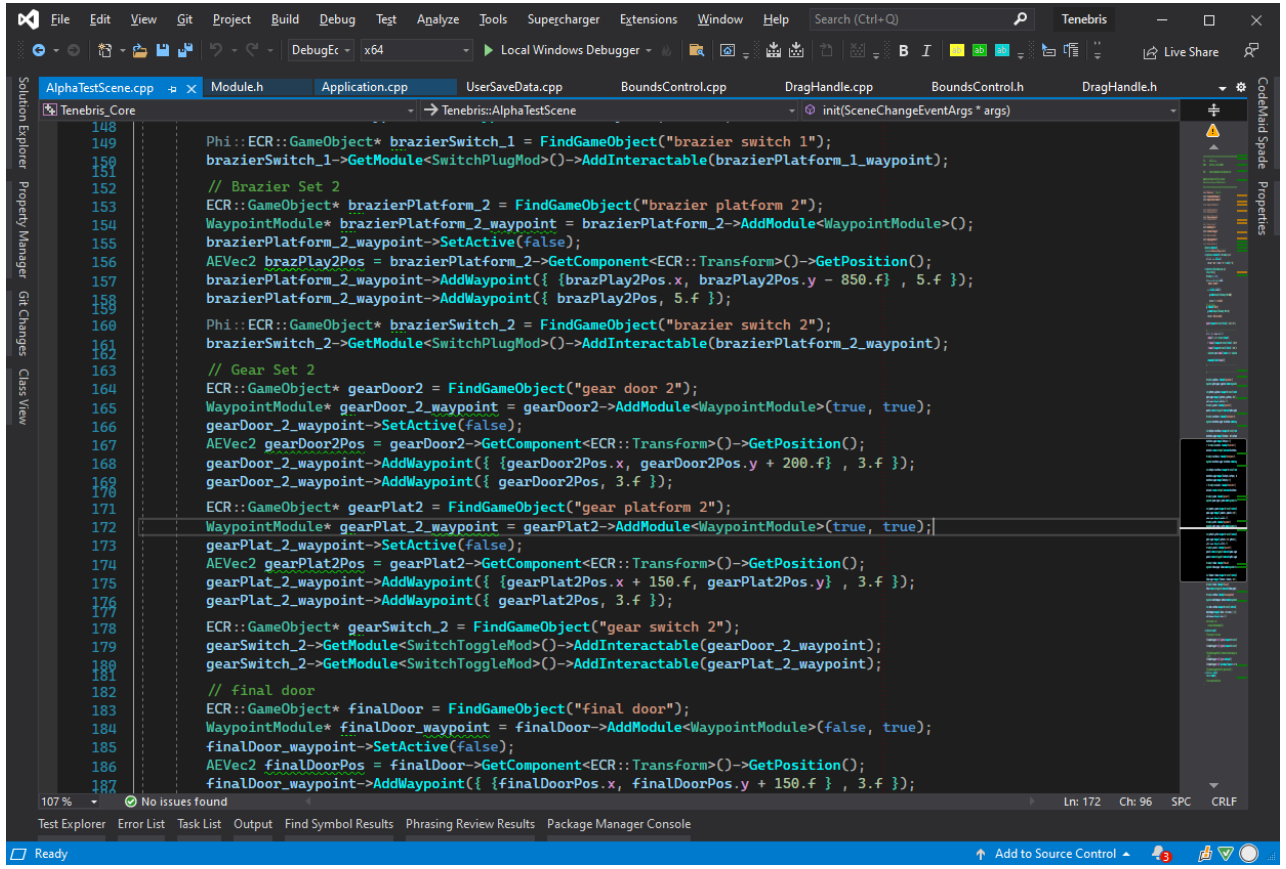
# Topics


Components of a Game Engine
Why Design Architectures
How to Design Architectures
Various Systems
Project Set Up
Tips & Tricks

# What's a game engine made of?



# Why care about architecture?



# Key Parts of an Engine Architecture

Game Entities

Systems

Game Loops

Etc

# Designing an Architecture

# Mindset

No such thing as the best architecture

Architecture design is an art form

But there is bad art

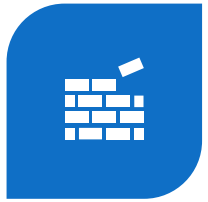
**DESIGNING AN ARCHITECTURE**

# Goals

Easy to Use

Data Driven

Clean



Not Obstructive

Extensible

Modular

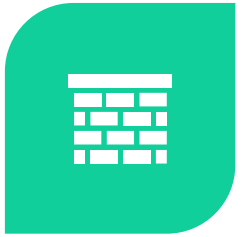
**DESIGNING AN ARCHITECTURE**

# Code Smells

Symptoms of a problems in the architecture.

Rigidity

Fragility



Immobility

Viscosity

DESIGNING AN ARCHITECTURE

# Conceptualise Usage

**Conceptualise**

How would you want to use the system?

**Research**

Is it possible to do it that way?

**Plan**

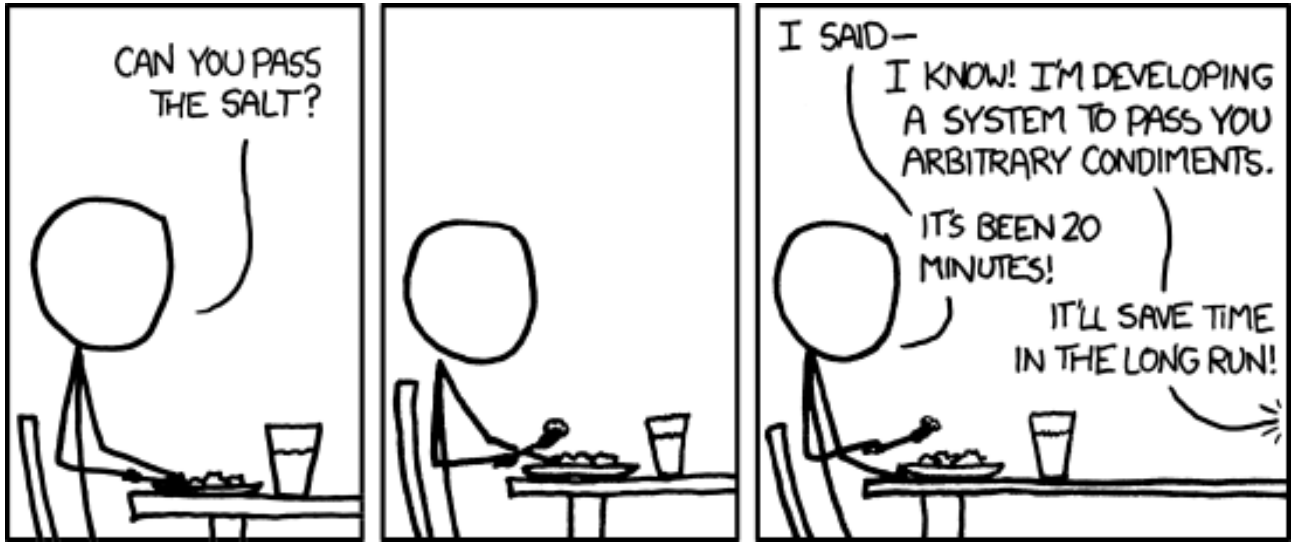
Would it get messy?

**Test**

Does it work in practice?

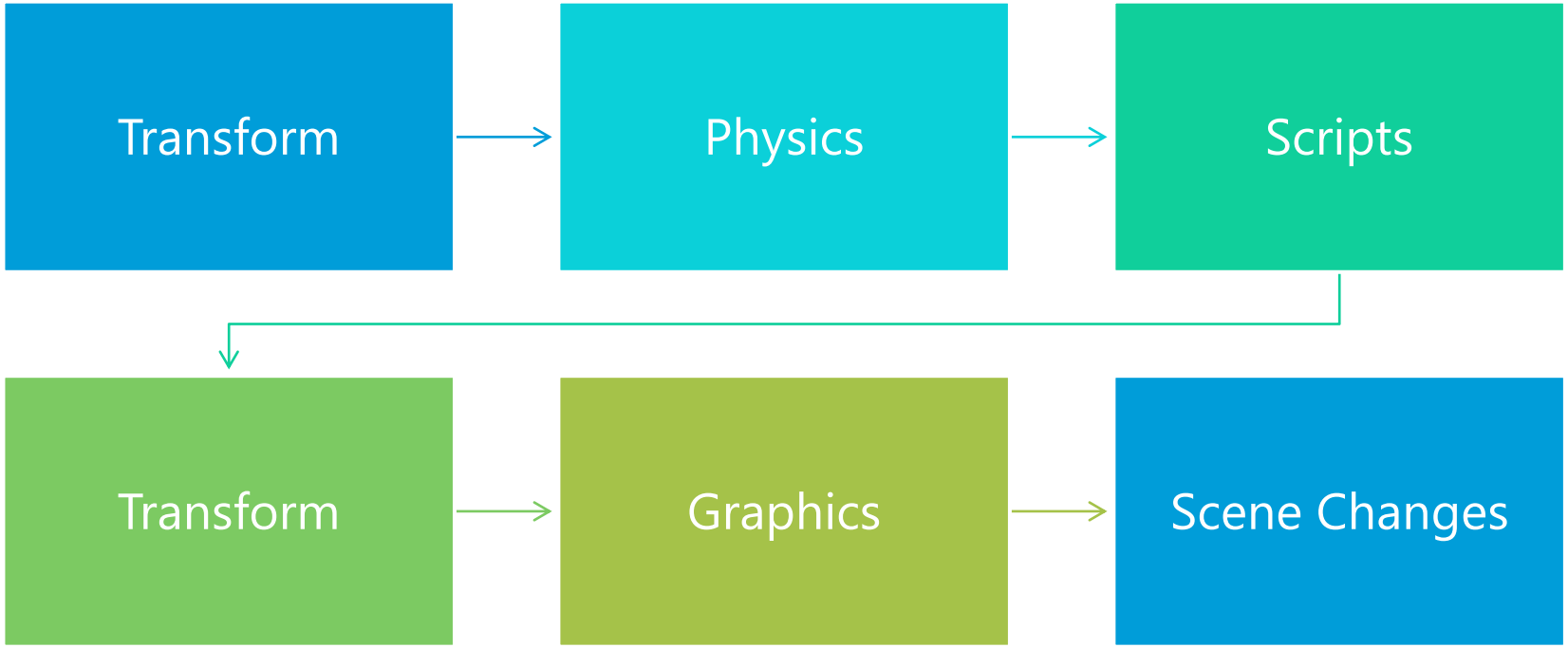
**DESIGNING AN ARCHITECTURE**

# Abstractions & Overengineering



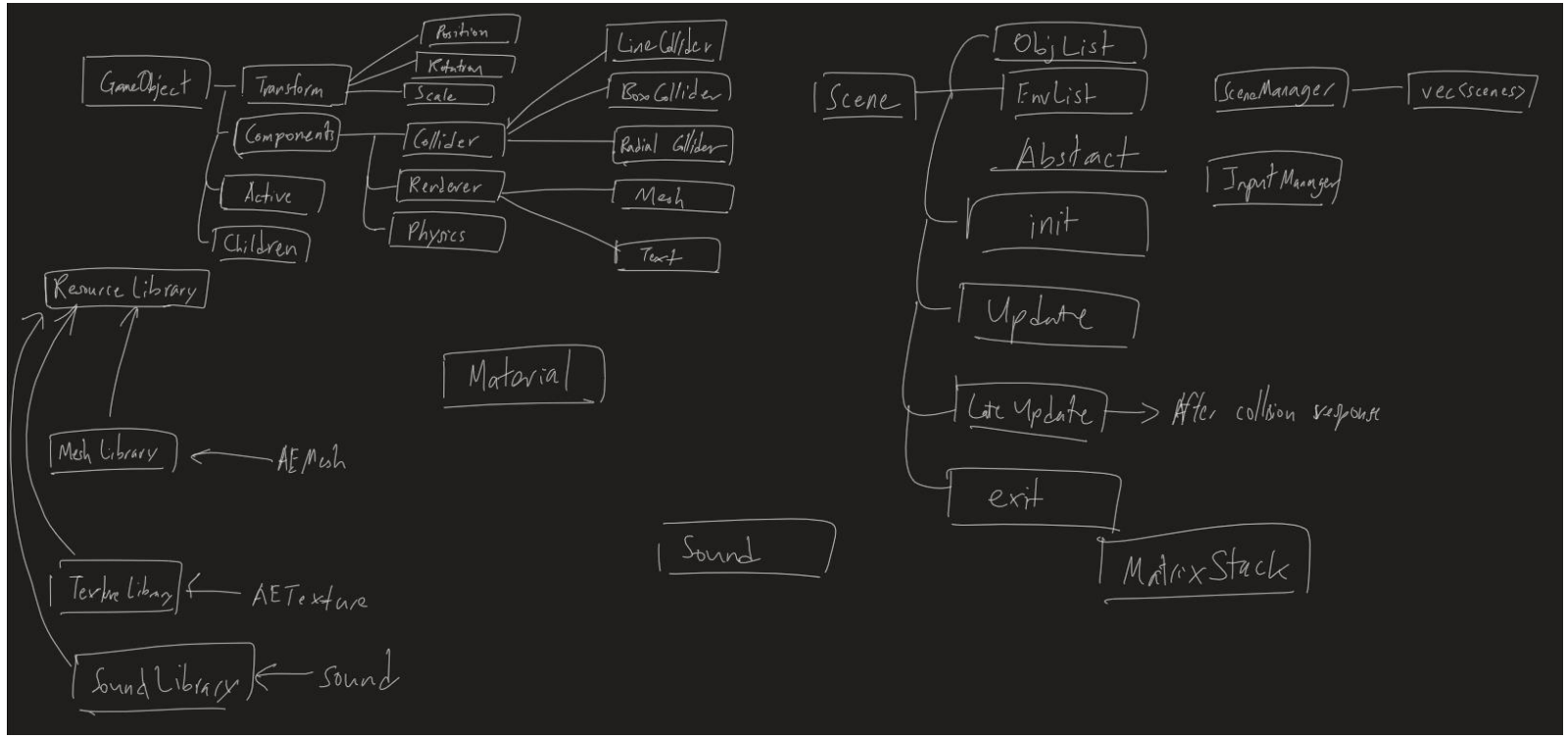
DESIGNING AN ARCHITECTURE

# Sequence of System Updates



## DESIGNING AN ARCHITECTURE

# Draw Diagrams



**DESIGNING AN ARCHITECTURE**

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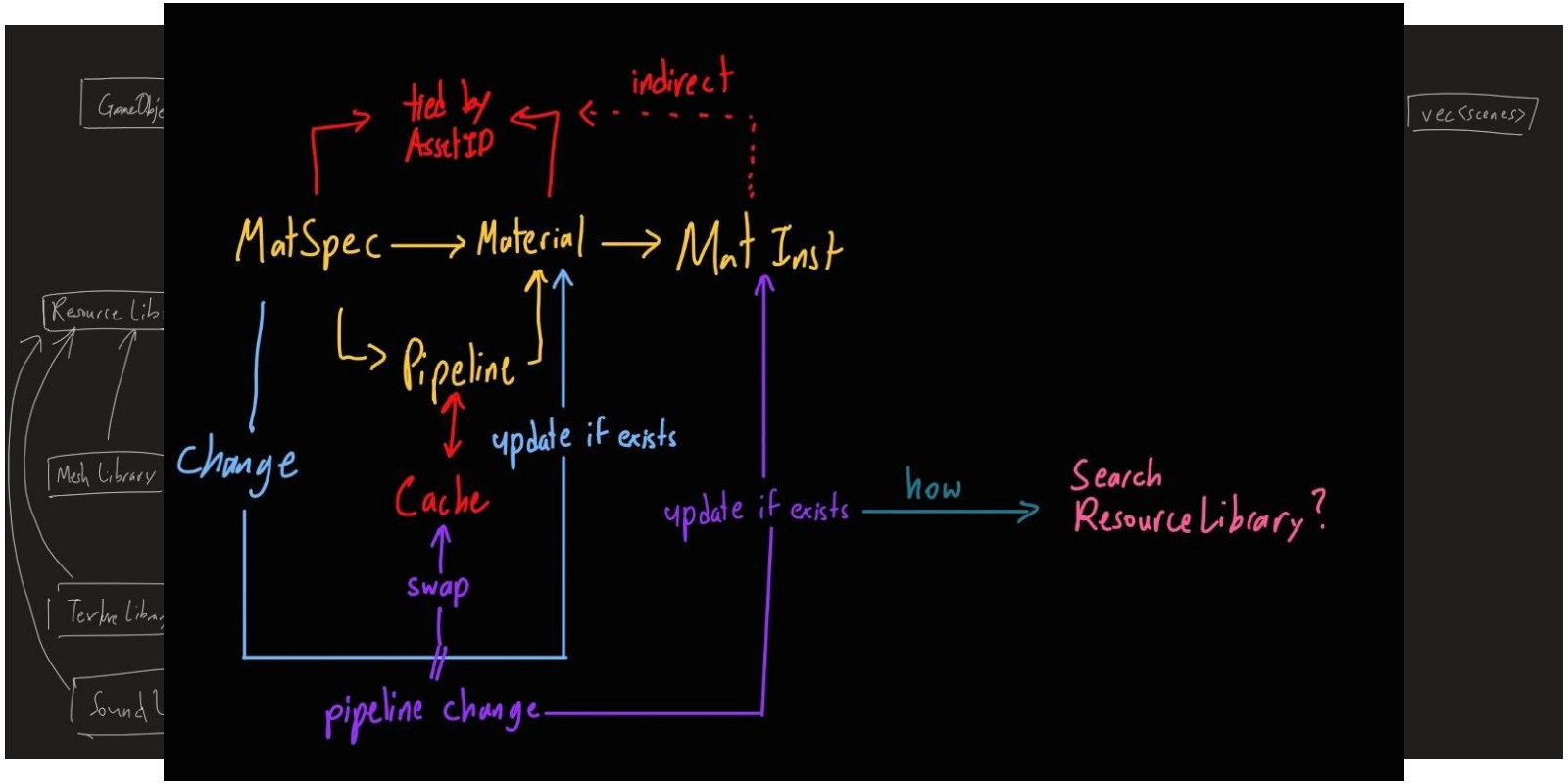

**DESIGNING AN ARCHITECTURE**

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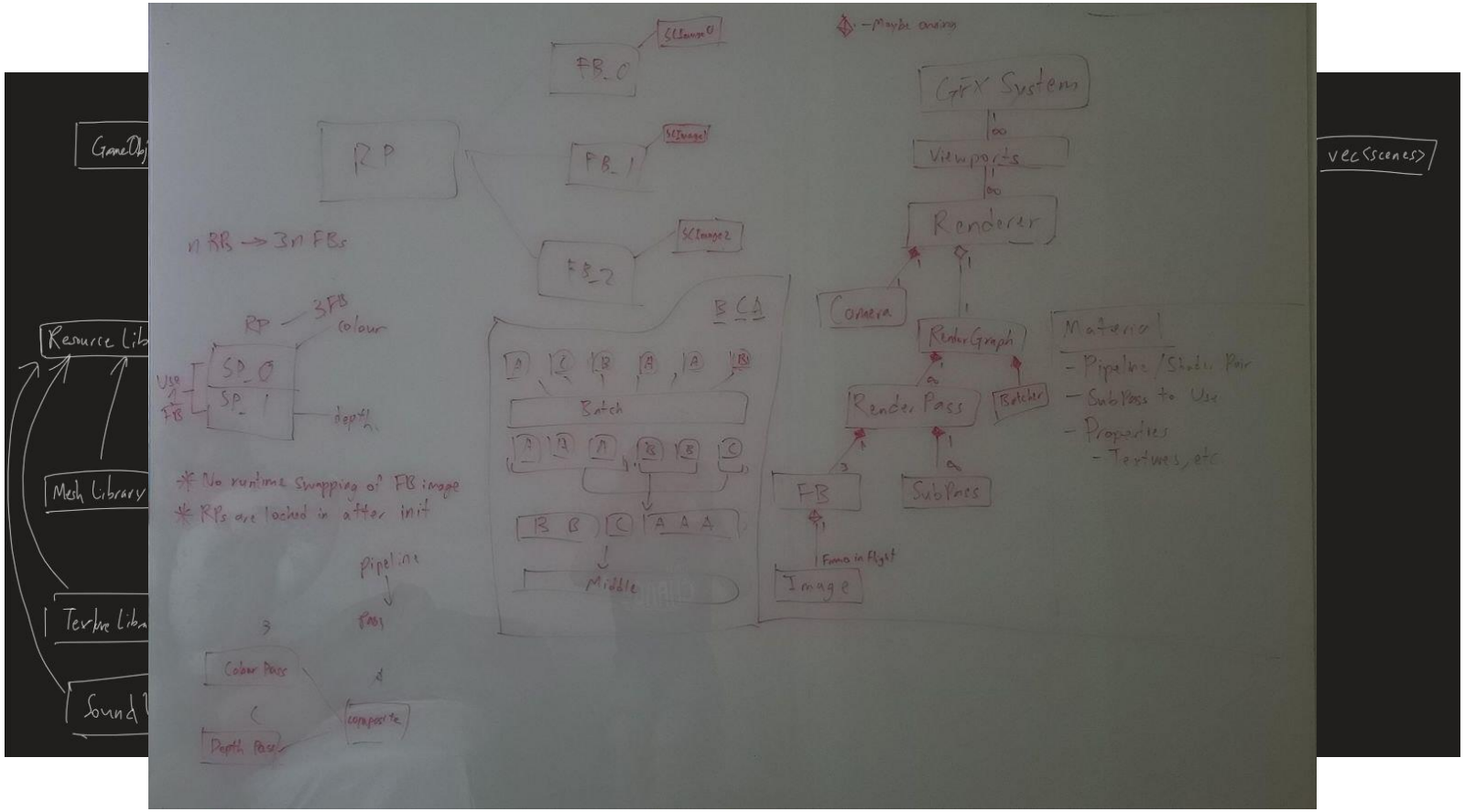

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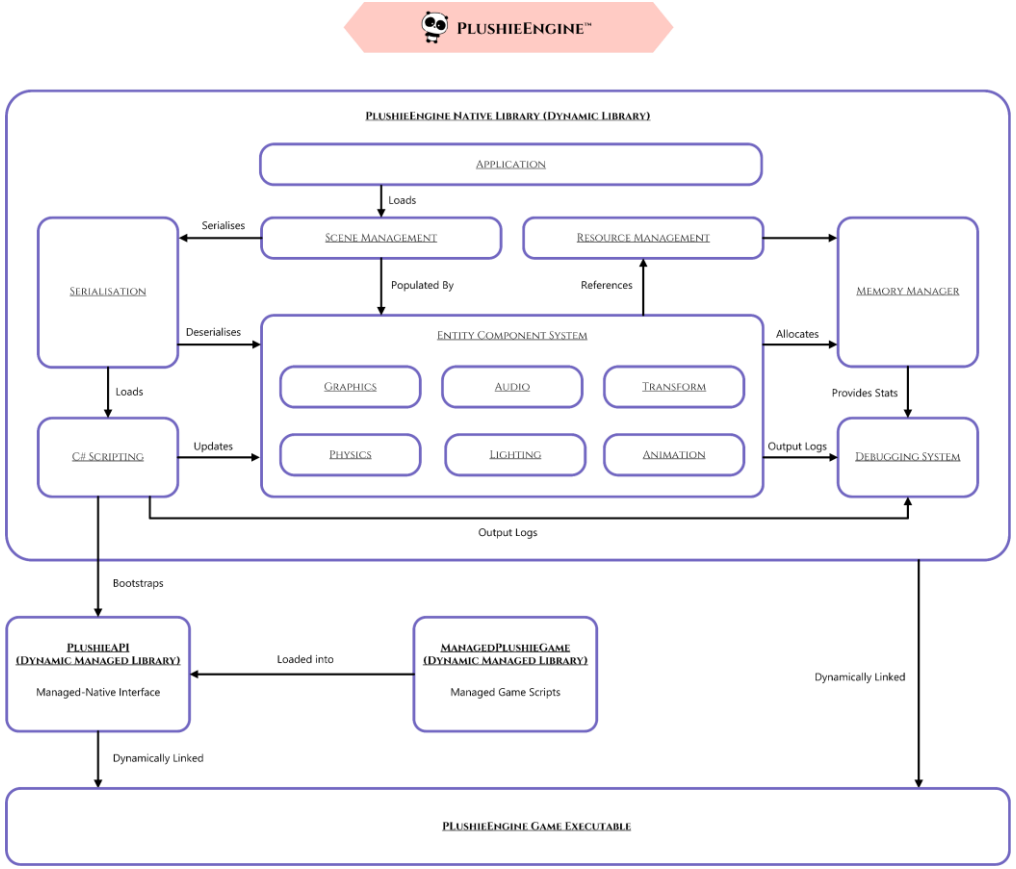

## DESIGNING AN ARCHITECTURE

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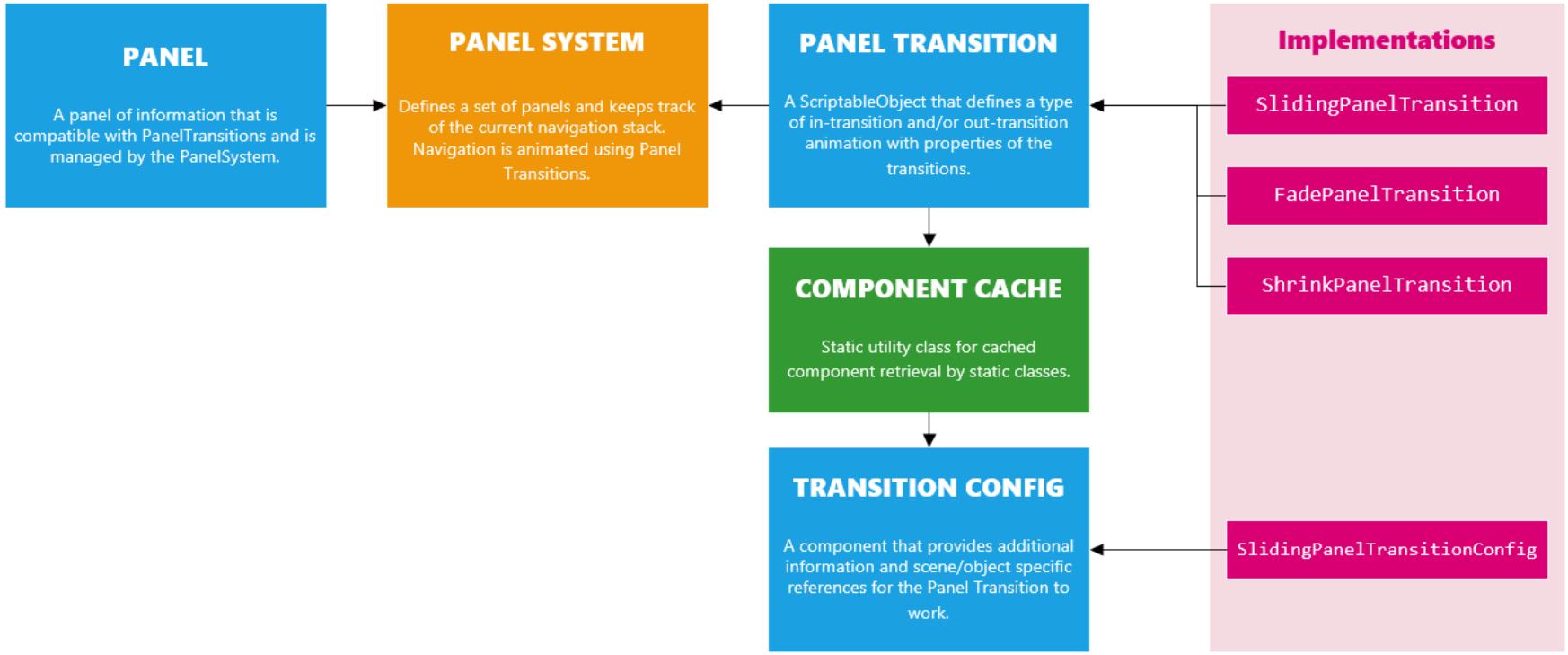
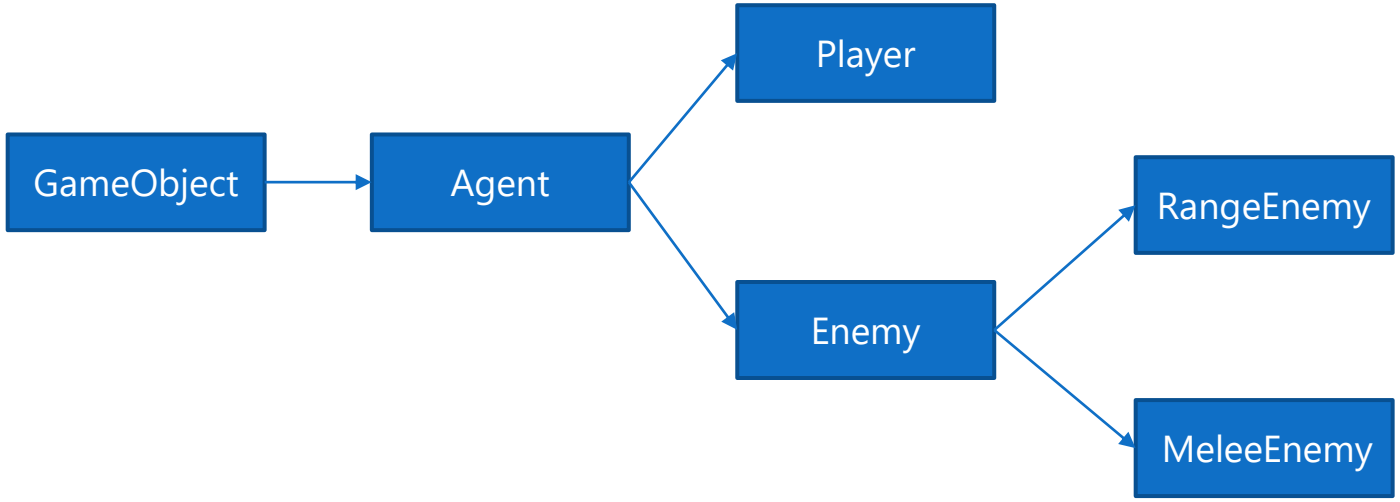


# Individual Systems

**GAME OBJECTS SYSTEM**

# Inheritance-Based

Simplest implementation.



**GAME OBJECTS SYSTEM**

# Inheritance-Based

Simplest implementation.

## Pros

- Simple to implement
- Intuitive to work with
- Easy to debug

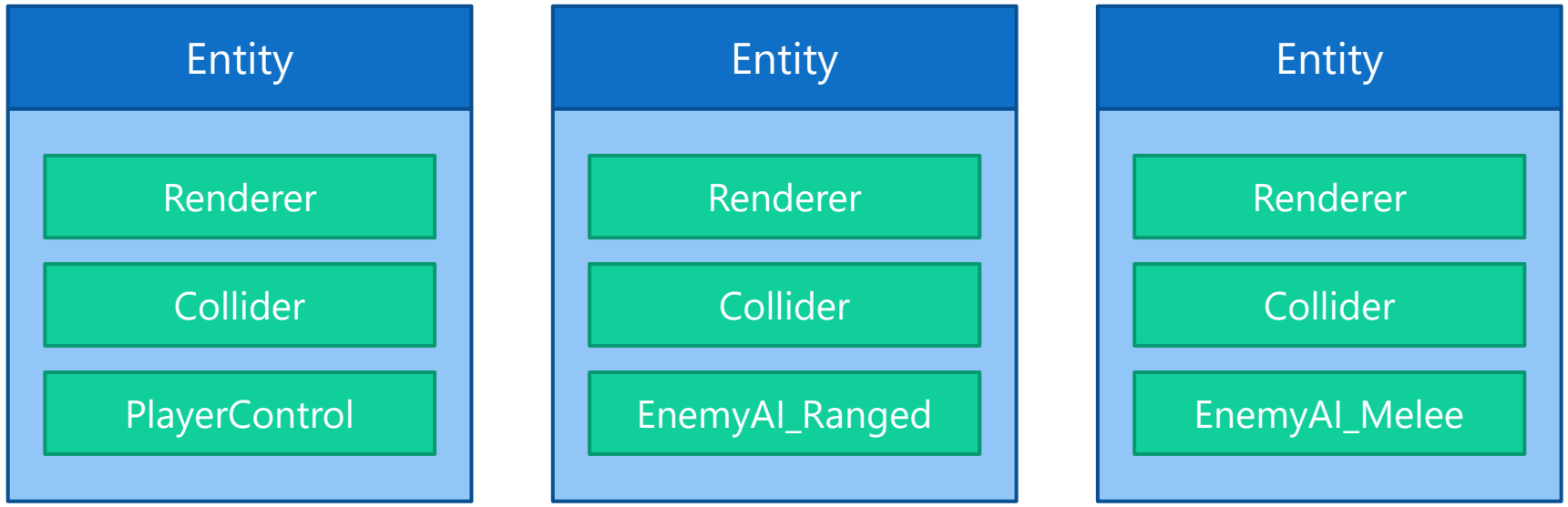
## Cons

- Hard to extend
- Multiple virtual calls
  - Slow
- Spaghetti
- Hard to visualise relations

**GAME OBJECTS SYSTEM**

# Entity Component

**Composition** based system.



**GAME OBJECTS SYSTEM**

# Entity Component

**Composition** based system.

## Pros

- Slightly harder to implement
- Intuitive to work with
- Code reuse via components
- Cleaner design

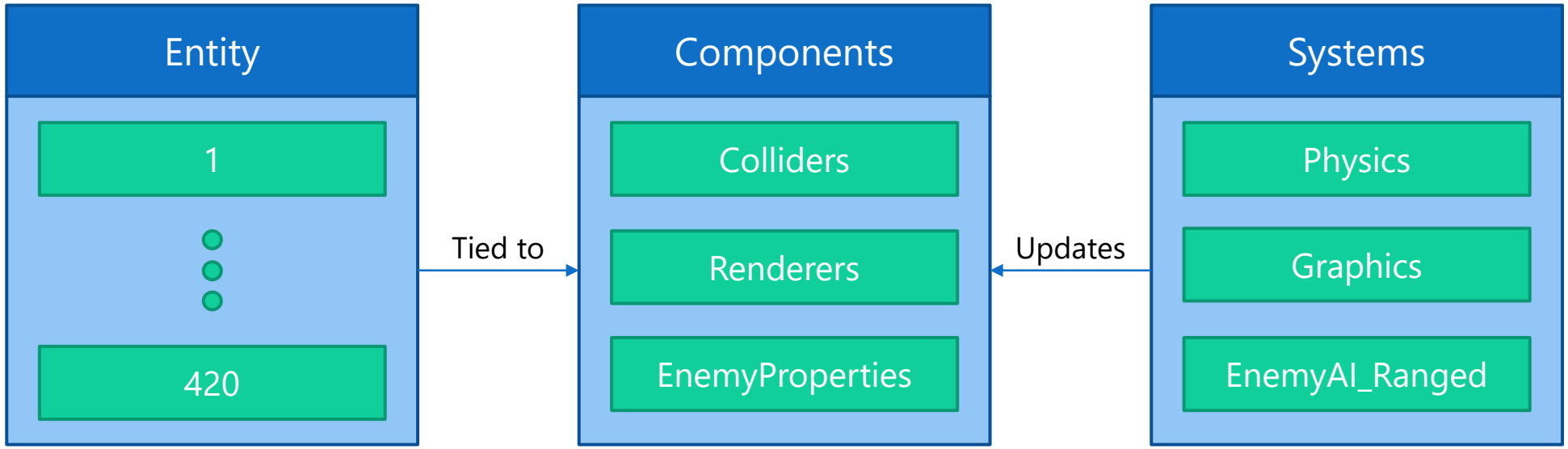
## Cons

- Multiple virtual calls
- Bad cache locality
  - Slow

**GAME OBJECTS SYSTEM**

# Entity Component System

Data-driven component-based architecture.




Will be talked in-depth about in a future lecture.

**GAME OBJECTS SYSTEM**

# Entity Component System

Data-driven component-based architecture.

## Pros

- Maximizes cache locality
  - Very fast
- Clear separation of concerns
- Very clean design

## Cons

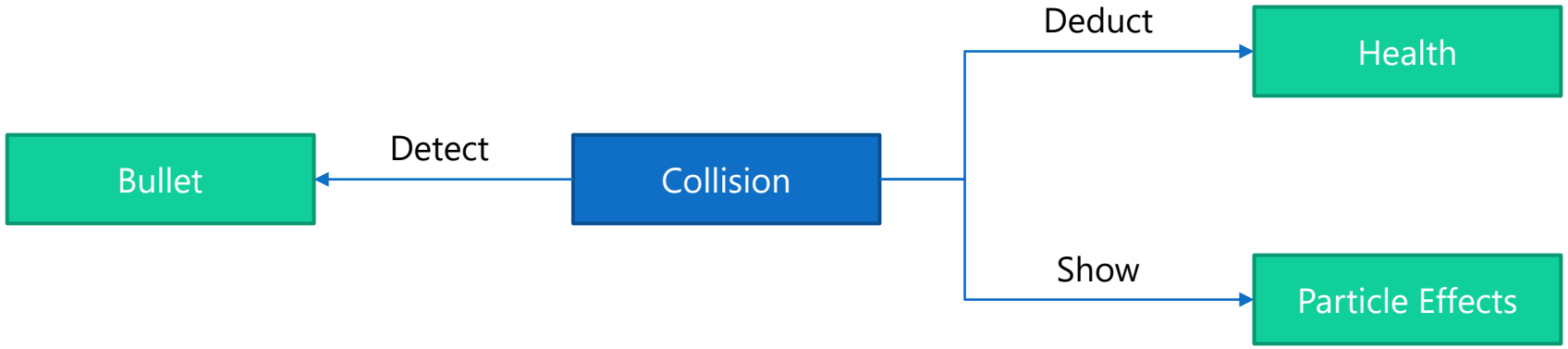
- Can be hard to debug
- Difficult to implement
- Complicated to understand

Will be talked in-depth about in a future lecture.

**EVENT/MESSAGING SYSTEM**

# Why have one?

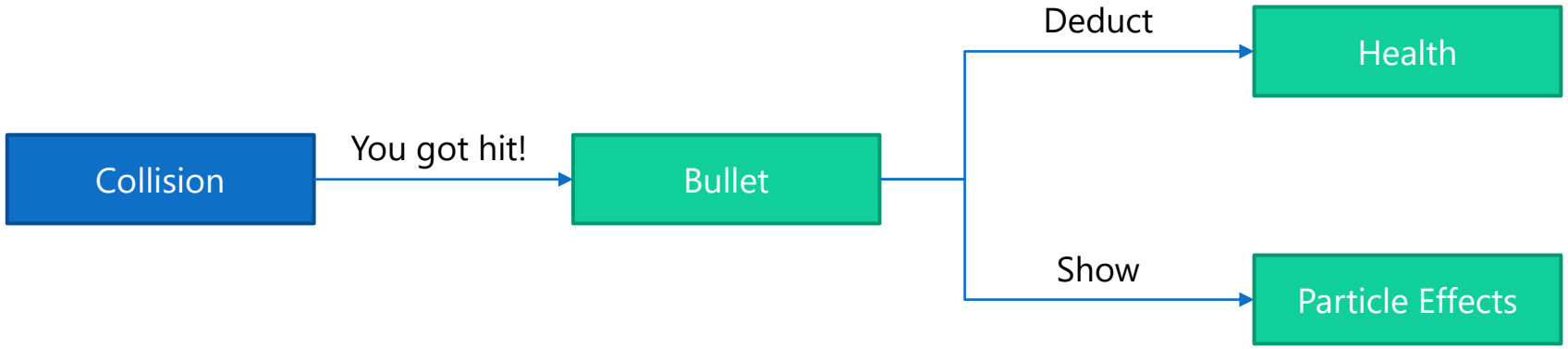
A way to separate gameplay logic from systems.



**EVENT/MESSAGING SYSTEM**

# Observer Pattern

"Let me know when it happens"



**EVENT/MESSAGING SYSTEM**

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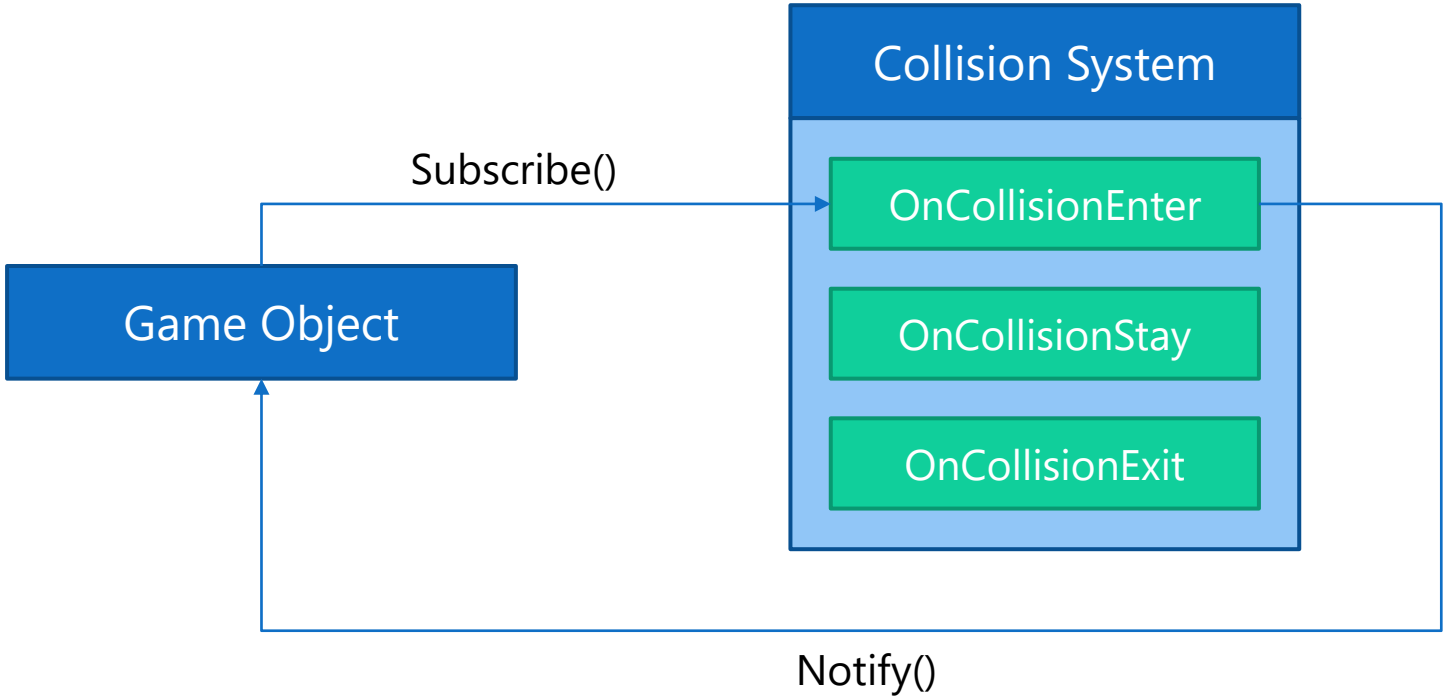

**EVENT/MESSAGING SYSTEM**

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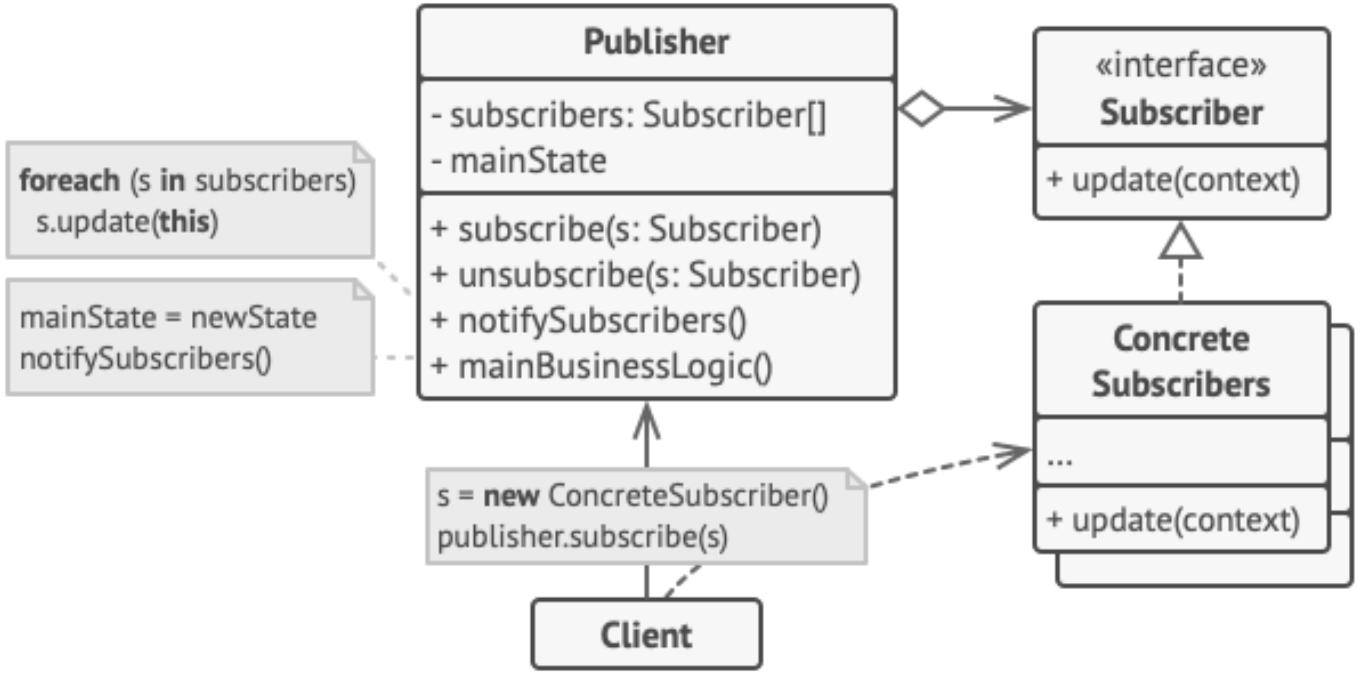


**EVENT/MESSAGING SYSTEM**

# Observer Pattern

"Let me know when it happens"

## Pros

- Systems are decoupled from gameplay logic
- Easily extensible

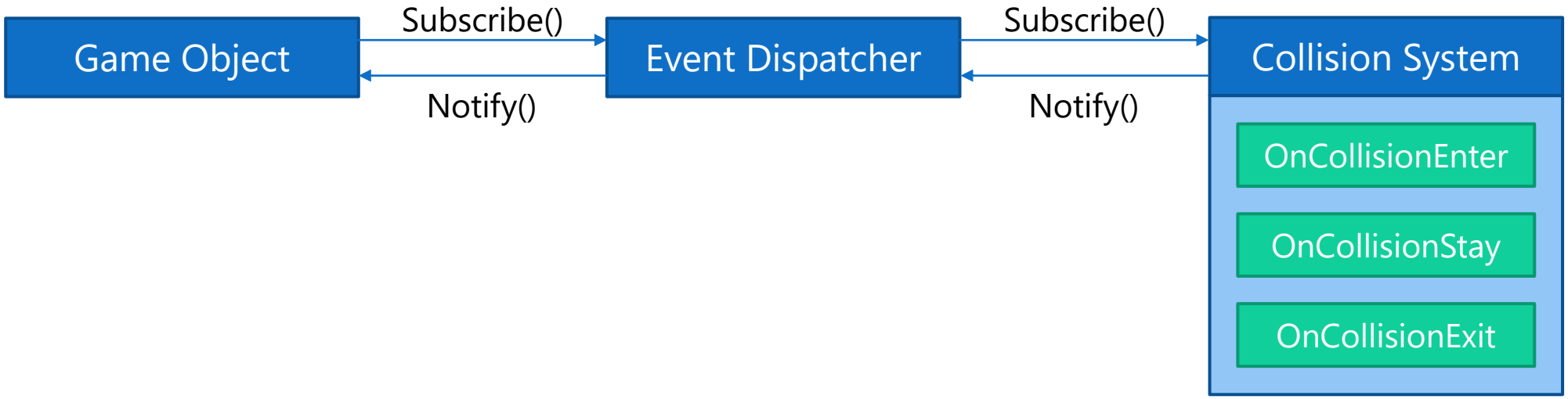
## Cons

- Cannot ensure execution order
- Requires dynamic dispatch
- Gameplay logic still needs to be able to interact with the system

**EVENT/MESSAGING SYSTEM**

# Dispatcher

Additional layer to the observer pattern.



**EVENT/MESSAGING SYSTEM**

# Dispatcher

Additional layer to the observer pattern.

## Pros

- Systems are decoupled from gameplay logic **and systems**
- Easily extensible
- Events can be deferred
- Order can be controlled

## Cons

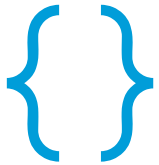
- Requires dynamic dispatch

# Setting Up Your Project

**SETTING UP YOUR PROJECT**

# Decide Your SDK

Best to figure these out **before writing any code**.



C++ Standard

Types of Projects

Dependencies

**SETTING UP YOUR PROJECT**

# Standardise Your Conventions

Assets in 4 different folder paths? Not fun.

| | | | |
|---|---|---|---|
| Source Control | Build Directories | Intermediate Directories | Asset Directories |
| Extern Dependencies Directories | File Names | Folder Names | .h and .cpp in the same folder? |

**SETTING UP YOUR PROJECT**

# Source Control

Are you using it effectively?

Remote Host

Client

Branches

Tags

Merging

**IN SUMMARY**

# Key Takeaways

Start Planning

Start Discussing

Start Prototyping


Ask Questions Early

# Tips & Tricks

**TIPS & TRICKS**

# Document, Document, Document

For your team **and yourself** who will probably forget.

```
float Q_rsqrt( float number )
{
    long i;
    float x2, y;
    const float threehalfs = 1.5F;

    x2 = number * 0.5F;
    y  = number;
    i  = * ( long * ) &y;                       // evil floating point bit level hacking
    i  = 0x5f3759df - ( i >> 1 );               // what the f***?
    y  = * ( float * ) &i;
    y  = y * ( threehalfs - ( x2 * y * y ) );   // 1st iteration
//  y  = y * ( threehalfs - ( x2 * y * y ) );   // 2nd iteration, this can be removed

    return y;
}
```

**TIPS & TRICKS**

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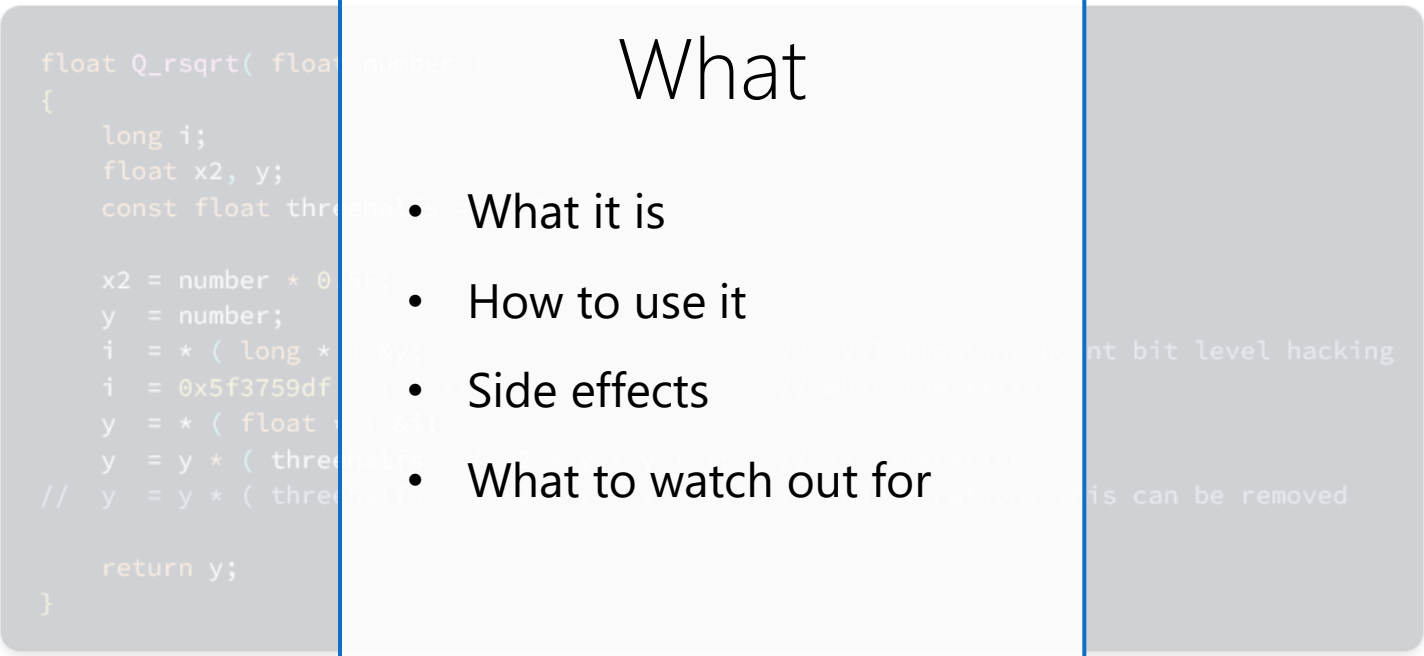



## What

- What it is
- How to use it
- Side effects
- What to watch out for

**TIPS & TRICKS**

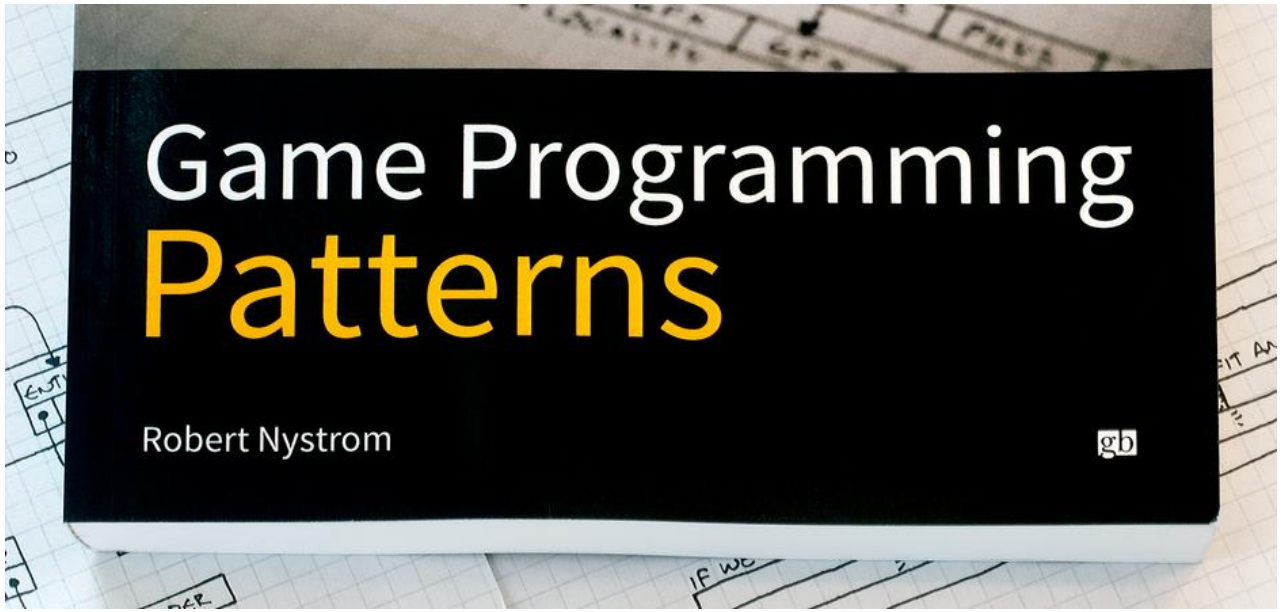
# Const When You Can

Prevents things from being changed if they aren’t supposed to.

```
const const const int const const const AN_INT = 420;
```

**TIPS & TRICKS**

# Read Up on Design Patterns




https://gameprogrammingpatterns.com/

https://refactoring.guru/

**TIPS & TRICKS**

# Use `<chrono>`

Stop using `<ctime>`

```
#include <iostream>
#include <chrono>

using Time         = std::chrono::steady_clock;
using MilliSeconds = std::chrono::duration<float, std::milli>;
using TimePoint    = std::chrono::time_point<Time, MilliSeconds>;

int main()
{
    const TimePoint START_TIME = Time::now();
    while (true)
    {
        const MilliSeconds TIME_PASSED = Time::now() - START_TIME;
        std::cout << "Time since start: " << TIME_PASSED.count() << " ms" << std::endl;
    }
}
```

**TIPS & TRICKS**

# Unit Types

Makes converting between units easy.

```
struct Degrees
{
  public:
    Degrees(float f);
    Degrees(Radians r);

    explicit operator Radians() const;
    operator float() const;

  private:
    float angle = 0.0f;
};
```

```
struct Radians
{
  public:
    Radians(float f);
    Radians(Degrees r);

    explicit operator Degrees() const;
    operator float() const;

  private:
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```

**TIPS & TRICKS**

# Unit Types

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```
struct Degrees
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  public:
    Degrees(float f)
    Degrees(Radians

    explicit operato
    operator float()

  private:
    float angle = 0.0f;
};
```

```
void RotateObject(Radians r);

const Degrees ANGLE = 45.0f;
RotateObject(ANGLE);
```

```
struct Radians
{
                                  s() const;

    float angle = 0.0f;
};
```

**TIPS & TRICKS**

# Loading Screens

You don’t need multi-threading.

| Frame 1 | Frame 2 | Frame 3 | Frame 4 |
|---|---|---|---|
| Texture1 | Texture3 | Audio2 | Texture6 |
| Texture2 | Texture4 | Audio3 | Texture7 |
| Audio1 | Texture5 | Audio4 | Audio5 |

# Thanks for Listening

Any Questions?