



Sound & Services



Soundsystem

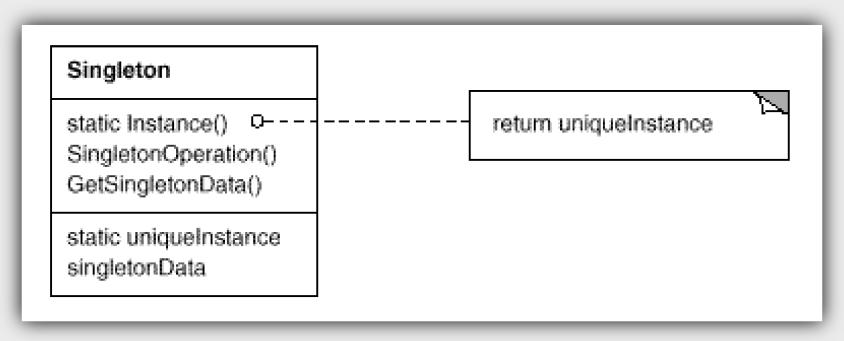
We're going to try and create a sound system for our engine.

Main function: playing a sound at a certain volume.

Who are our clients and how do we get them to play a sound? (Remember Event Queue)



Singleton



"Ensure a class has only one instance and provide a global point of access to it."

```
using sound_id = unsigned short;
class sound_system
  static sound_system* instance;
public:
  static sound_system* instance()
    if(instance == nullptr)
      instance = new sound_system();
    return instance;
  void play(sound_id id, float volume)
    // ... code that plays sound "id" at given volume ...
};
```

```
using sound_id = unsigned short;
class sound_system
  static sound_system* instance;
  sound_system() = default;
public:
  static sound_system* instance()
    if(instance == nullptr)
      instance = new sound_system();
    return instance;
  void play(sound_id id, float volume)
    // ... code that plays sound "id" at given volume ...
};
```

```
using sound_id = unsigned short;
class sound_system
  static sound_system* instance;
  sound_system() = default;
  sound_system(const sound_system& other) = delete;
  sound_system(sound_system&& other) = delete;
  sound_system& operator=(const sound_system& other) = delete;
  sound_system& operator=(sound_system&& other) = delete;
public:
  static sound_system* instance()
    if(instance == nullptr)
      instance = new sound_system();
    return instance;
  void play(sound_id id, float volume)
    // ... code that plays sound "id" at given volume ...
};
```

```
using sound_id = unsigned short;
class sound_system
  static std::mutex mutex;
  static sound_system* instance;
  sound_system() = default;
  sound_system(const sound_system& other) = delete;
  sound_system(sound_system&& other) = delete;
  sound_system& operator=(const sound_system& other) = delete;
  sound_system& operator=(sound_system&& other) = delete;
public:
  static sound_system* instance()
    std::lock_guard<std::mutex> lock(mutex);
    if(instance == nullptr)
      instance = new sound_system();
    return instance;
  void play(sound_id id, float volume)
    // ... code that plays sound "id" at given volume ...
};
```

```
using sound_id = unsigned short;
class sound_system
  sound_system() = default;
  sound_system(const sound_system& other) = delete;
  sound_system(sound_system&& other) = delete;
  sound_system& operator=(const sound_system& other) = delete;
  sound_system& operator=(sound_system&& other) = delete;
public:
  static sound_system& instance()
    static sound_system instance{};
    return instance;
  void play(sound_id id, float volume)
    // ... code that plays sound "id" at given volume ...
};
```

Implementation - CRTP

```
template <typename T>
class singleton
public:
  static T& instance()
    static T instance{};
    return instance;
  virtual ~singleton() = default;
  singleton(const singleton& other) = delete;
  singleton(singleton&& other) = delete;
  singleton& operator=(const singleton& other) = delete;
  singleton& operator=(singleton&& other) = delete;
protected:
  singleton() = default;
};
```

```
using sound_id = unsigned short;
class sound_system final :
  public singleton<sound_system>
{
  friend class singleton<sound_system>;
  sound_system() = default;
public:
  void play(sound_id id, float volume)
  {
    // ... code that plays sound "id" at given volume)
  }
};
```

Singleton

But Singletons have a bad rep. It's sometimes deemed an "Anti-Pattern"

- They're still global variables
- These couple code tightly.
- And invisibly.
- Tons of singles
- Difficult to unit test

```
class SomeClass {
public:
   void SomeMethod() {
     Actor a = ActorManager::instance().GetActor(someId);
     // do someting with the actor
   }
};
```

An alternative is **dependency injection**.

Dependency injection

"Dependency injection" is a fancy word for giving an object or method its instance variables or parameters needed to do the job.

```
class SomeClass {
public:
   void SomeMethod(ActorManager& actorManager) {
     Actor a = actorManager.GetActor(someId);
     // do someting with the actor
   }
};
```

It solves two problems: the dependency is now visible and you can unit test.

- It's still tightly coupled though.
- You don't want to pass the logging system to every method...
- Time is also an example that can be cumbersome.

Service locator

Using a singleton couples the calling code to the concrete implementation of the class.

"That's like giving 10000 strangers your phone number so they can call you" - That makes a service locator the telephone book.

The service locater itself is a singleton, or completely static.

- Services register for duty with the locator.
- Clients must keep in mind that the service might not be found!

The service:

```
using sound_id = unsigned short;
class sound_system
{
public:
    virtual ~sound_system() = default;
    virtual void play(const sound_id id, const float volume) = 0;

    // ...and other relevant methods of course...
};
```

Is an *interface*!

```
using sound_id = unsigned short;
class sound_system
{
public:
    virtual ~sound_system() = default;
    virtual void play(const sound_id id, const float volume) = 0;
};
```

The locator:

```
class servicelocator final
{
   static std::unique_ptr<sound_system> _ss_instance;
public:
   static sound_system& get_sound_system() { return *_ss_instance; }
   static void register_sound_system(std::unique_ptr<sound_system>&& ss) { _ss_instance = std::move(ss)};
```

Is *final*!

Usage:

```
class sdl_sound_system final : public sound_system :
public:
  void play(const sound_id id, const float volume) override {
    // lots of sdl_mixer code
  }
};
```

```
void main()
{
    // at the start: register a sound system
    servicelocator::register_sound_system(std::make_unique<sdl_sound_system>());

    // ...lots of code...

    // start using the sound system.
    auto& ss = servicelocator::get_sound_system();
    ss.play(10, 100);
}
```

Decorator

```
class logging_sound_system final : public sound_system {
   std::unique_ptr<sound_system> _real_ss;
public:
   logging_sound_system(std::unique_ptr<sound_system>&& ss) : _real_ss(std::move(ss)) {}
   virtual ~logging_sound_system() = default;

   void play(const sound_id id, const float volume) override {
     _real_ss->play(id, volume);
     std::cout << "playing " << id << " at volume " << volume << std::endl;
};

void main() {</pre>
```

```
#if _DEBUG
   servicelocator::register_sound_system(
     std::make_unique<logging_sound_system>(std::make_unique<sdl_sound_system>());
#else
   servicelocator::register_sound_system(std::make_unique<sdl_sound_system>());
#endif
   // ... code ...
   auto& ss = servicelocator::get_sound_system();
   ss.play(10, 100);
}
```

Service locator

Danger!

```
void main()
 // uh-oh
  auto& ss = servicelocator::get_sound_system();
  ss.play(10, 100);
 // ... code
  servicelocator::register_sound_system(std::make_unique<sdl_sound_system>());
 // ... code
  auto& ss = servicelocator::get_sound_system();
  ss.play(10, 100);
```

Default

```
class null_sound_system final : public sound_system
  void play(const sound_id, const float) override {}
};
class servicelocator final
  static std::unique_ptr<sound_system> _ss_instance;
public:
  static sound_system& get_sound_system() { return *_ss_instance; }
  static void register_sound_system(std::unique_ptr<sound_system>&& ss) {
    _ss_instance = ss == nullptr ? std::make_unique<null_sound_system>() : std::move(ss);
};
//... somehwere in a cpp:
std::unique_ptr<sound_system> servicelocator::_ss_instance{ std::make_unique<null_sound_system>() };
```

Service locator

You can change a service while running

- For muting the sound
- For applying a different render mode
- To have another input controller
- ...

The service locator does not have to be global, it can also be local to a class.

• The GetComponent<T>() method in Unity is exactly that.



Sound

What is it that this "play" function must do?

```
void dae::sdl_sound_system::play(const sound_id id, const float volume)
{
   auto audioclip = audioclips[id];
   if (!audioclip->is_loaded())
      audioclip->load();
   audioclip->set_volume(volume);
   audioclip->play();
}
```

- Load the audioclip if not loaded
- Set volume
- Play

Sound & Services

Sound

With a small test sound this takes ~9ms! That's half a frame!

```
auto start = high_resolution_clock::now();
servicelocator::get_sound_system().play(pacman::pacman_dies, 1.0f);
auto end = high_resolution_clock::now();
auto elapsed = duration_cast<microseconds>(end - start).count();
std::cout << "play took: " << elapsed << "ms\n";</pre>
```

What can help?

Exercise

Implement an audio system as a service that you get via a service locator.

Create these audio services:

- A regular one, that plays sounds
- A logging service, that **also** logs the sounds to std::cout

You can use **SDL_mixer** for this:

- https://github.com/libsdl-org/SDL_mixer
- But other sound systems are allowed too.

Exercise

The audio needs to be loaded and played on a different thread

Make use of an **Event Queue** to add "play sound" requests for the other thread Your thread processes the requests from the queue and while there is nothing in it, **does nothing**.

• Think: how would you implement this? The sound thread needs to be notified when there is work to be done.

Also think about Pimpl! We do not want to expose the used audio library to the user of our engine.

Submit a version of your engine + game where some sounds can be played

- Preferably via in game actions/events
- Or with a key if you don't have a game yet

The engine must be a **static library** by now.

Singletons in Unity

What I often see

```
public class GameController
{
  public GameController Instance { get; private set; }

  private void Awake()
  {
    if(Instance == null)
        Instance = this;
    else
        Destroy(gameObject);
  }

  // ... more code ...
}
```

What's wrong with this?

Check this

```
public abstract class MonoSingleton<T> : MonoBehaviour where T : MonoSingleton<T>
    static T m_Instance;
    static bool hasBeenCreated;
    public static T Instance { get {
      if (m_Instance == null)
          m_Instance = FindAnyObjectByType<T>();
          if (m_Instance == null)
              if (!hasBeenCreated)
                m_Instance = new GameObject("_" + typeof(T), typeof(T)).GetComponent<T>();
          else
            hasBeenCreated = true;
            DontDestroyOnLoad(m_Instance);
            m_Instance.Init();
          return m_Instance;
```

Check this

```
// If no other monobehaviour request the instance in an awake function
// executing before this one, no need to search the object.
private void Awake()
    DontDestroyOnLoad(this);
    if (m_Instance == null)
        m_Instance = this as T;
        hasBeenCreated = true;
        m_Instance.Init();
// This function is called when the instance is used the first time
// Put all the initializations you need here, as you would do in Awake
protected virtual void Init() { }
```

Not such a walk in the park;)