

# Unity Android SDK/NDK 俄罗斯方块砖 3D 小游戏

deepwaterooo

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**1 模块搭建**

- # only include two levels in TOC
- ILRuntime 的消理解, 以及与 MVVM 同用时的搭配理解消化
- 热更新模块服务器模块的理解与消化搭建:

**2 把原理弄懂**

- 热更新模块的实充: 以前的设计模式和实现的功能还是比较完整的; 现在更成熟一点儿, 需要把热更新模块补充出来;
- ILRuntime + MVVM 框架设计: 两者结合, 前几年的时候没能把 MVVM 理解透彻;
- 上次前几年主要的难点: 好像是在把 MVVM 双向数据绑定理解得不透彻; 那么这次应该就狠没有问题了, 更该寻求更好的设计与解决方案
- 性能优化: 另外是对其实高级开发的越来越熟悉, 希望应用的性能表现, 尤其是渲染性能与速度等、这些更为高级和深入的特性成为这次二次开发的重点。
- 现在是把自己几年前的写的游戏全忘记了, 需要回去把自己的源码找出来, 再读一读熟悉一下自己的源码, 了解当时设计的估缺点, 由此改进更将

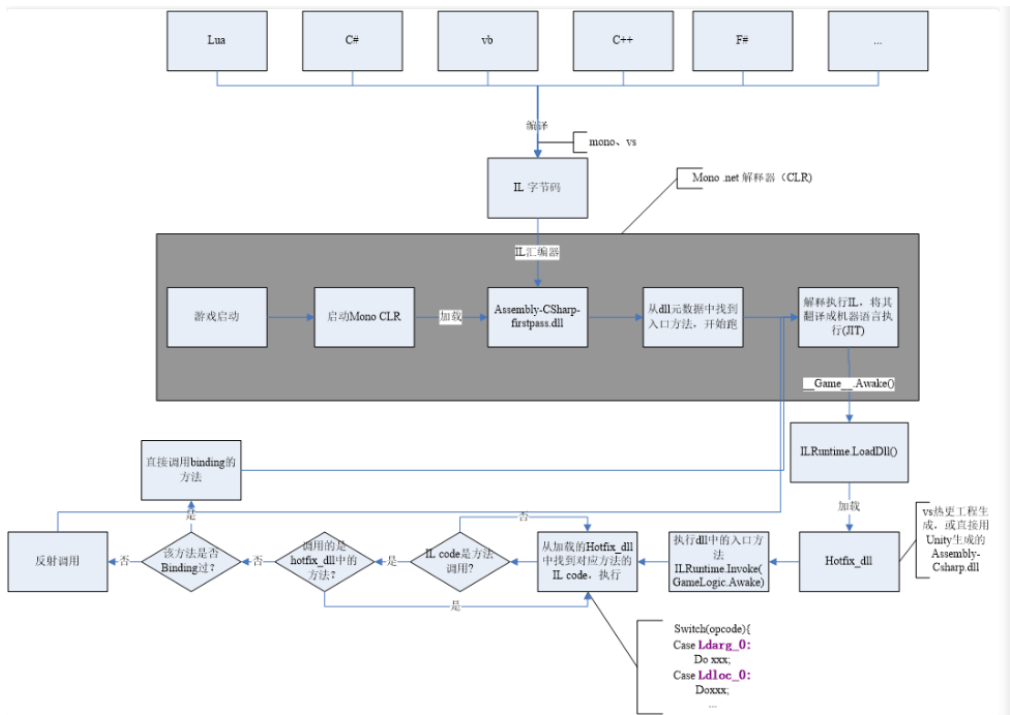
**3 环境弄得比较好的包括:**

- 输入法的搭建: 终于用到了自己之前用过的好用的输入法
- 这两天开车疲累, 最迟明天中午会去南湾找房间出租, 尽快解决搬家的问题; 昨天晚上回来得太晚了, 一路辛苦, 路上只差睡着, 回到家里补觉补了好多个小时。
- 小电脑, 笔记本电脑里的游戏环境搭建, 今天下午去图书馆里弄 (今天下午去图书馆里把需要借助快速网络来完成的事情都搭建好; 家里被恶房东故意整了个腾腾慢的网, 故意阻碍别人的发展, 谁还愿意再这样的环境中继续住下去呢?!!!)
- 能够把程序源码读得比较懂, 也并不代表把所有相关的原理就全部弄懂了; 不是说还有多在的挑战, 而是说要不断寻找更为有效的学习方法, 快速掌握所有涉及到的相关原理; 在理解得更为深入掌握了基本原理的基础上再去读源码, 会不会更为有效事半功倍呢? 这是一颗永远不屈服的心, 爱表哥, 爱生活!!!

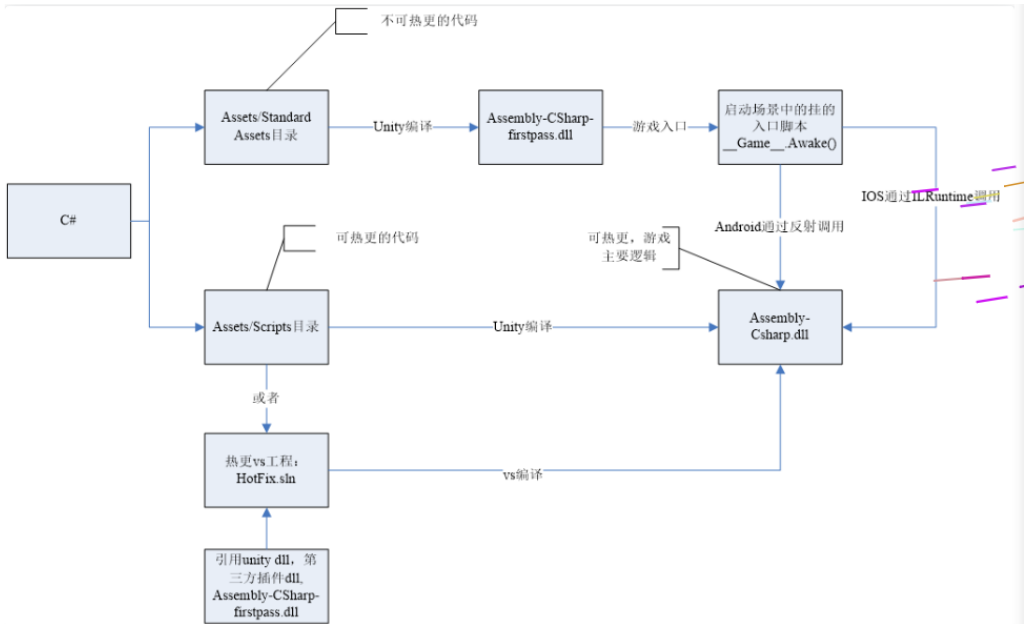
## 4 ILRuntime 库的系统再深入理解

### 4.1 ILRuntime 基本原理

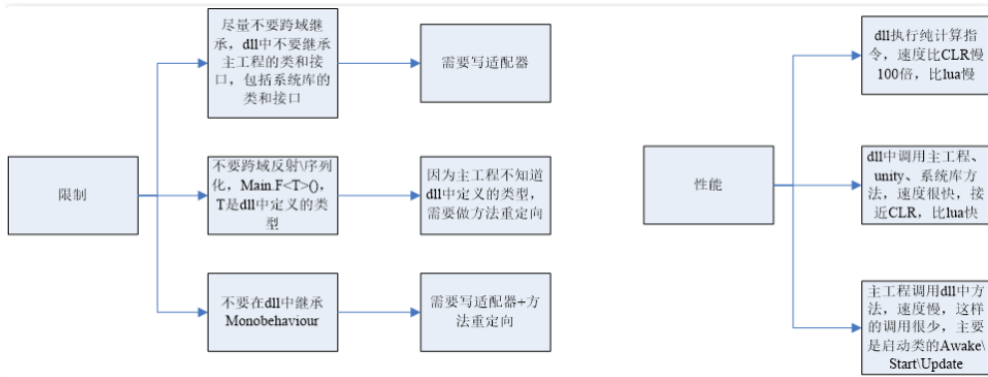
- ILRuntime 借助 Mono.Cecil 库来读取 DLL 的 PE 信息，以及当中类型的所有信息，最终得到方法的 IL 汇编码，然后通过内置的 IL 解译执行虚拟机来执行 DLL 中的代码。IL 解释器代码在 ILInterpreter.cs，通过 Opcode 来逐语句执行机器码，解释器的代码有四千多行。



### 4.2 ILRuntime 热更流程



## 4.3 ILRuntime 主要限制



- **委托适配器 (DelegateAdapter)**: 将委托实例传出给 ILRuntime 外部使用, 将其转换成 CLR 委托实例。

由于 IL2CPP 之类的 AOT 编译技术无法在运行时生成新的类型, 所以在创建委托实例的时候 ILRuntime 选择了显式注册的方式, 以保证问题不被隐藏到上线后才发现。

```
// 同一参数组合只需要注册一次
delegate void SomeDelegate(int a, float b);
Action<int, float> act;
// 注册, 不带返回值, 最多支持五个参数传入
appDomain.DelegateManager.RegisterMethodDelegate<int, float>();

// 注册, 带参数返回值, 最后一个参数为返回值, 最多支持四个参数传入
delegate bool SomeFunction(int a, float b);
Func<int, float, bool> act;
```

- **委托转换器 RegisterDelegateConverter**: 需要将一个不是 Action 或者 Func 类型的委托实例传到 ILRuntime 外部使用, 需要写委托适配器和委托转换器。委托转换器将 Action 和 Func 转换为你真正需要的那个委托类型

```
app.DelegateManager.RegisterDelegateConverter<SomeFunction>((action) =>
{
    return new SomeFunction((a, b) =>
    {
        return ((Func<int, float, bool>)action)(a, b);
    });
});
```

- 为了避免不必要的麻烦, 以及后期热更出现问题, 建议: 1、尽量避免不必要的跨域委托调用 2、尽量使用 Action 以及 Func 委托类型
- **CLR 重定向**: ILRuntime 为了解决外部调用内部接口的问题, 引入了 CLR 重定向机制。原理就是当 IL 解释器发现需要调用某个指定 CLR 方法时, 将实际调用重定向到另外一个方法进行挟持, 再在这个方法中对 ILRuntime 的反射的用法进行处理
- 从代码中可以看出重定向的工作是把方法挟持下来后装到 ILIntepreter 的解释器里面实例化
- 不带返回值的重定向:

```
public static StackObject* CreateInstance(ILIntepreter intp, StackObject* esp,
                                          List<object> mStack, CLRMethod method, bool isNewObj) {
    // 获取泛型参数 <T> 的实际类型
    IType[] genericArguments = method.GenericArguments;
    if (genericArguments != null && genericArguments.Length == 1) {
        var t = genericArguments[0];
        if (t is ILType) { // 如果 T 是热更 DLL 里的类型
            // 通过 ILRuntime 的接口来创建实例
            return ILIntepreter.PushObject(esp, mStack, ((ILType)t).Instantiate());
        } else // 通过系统反射接口创建实例
            return ILIntepreter.PushObject(esp, mStack, Activator.CreateInstance(t.TypeForCLR));
    }
```

```

    } else
        throw new EntryPointNotFoundException();
}
// 注册
foreach (var i in typeof(System.Activator).GetMethods()) {
    // 找到名字为 CreateInstance, 并且是泛型方法的方法定义
    if (i.Name == "CreateInstance" && i.IsGenericMethodDefinition) {
        // RegisterCLRMethodRedirection: 通过 redirectMap 存储键值对 MethodBase-CLRRedirectionDelegate, 如果 i 不为空且 redirectMap 不为空
        appdomain.RegisterCLRMethodRedirection(i, CreateInstance);
    }
}
}

```

- 带返回值方法的重定向

```

public unsafe static StackObject* DLog(ILIntepreter __intp, StackObject* __esp,
                                       List<object> __mStack, CLRMethod __method, bool isNewObj) {
    ILRuntime.Runtime.Enviorment.AppDomain __domain = __intp.AppDomain;
    StackObject* ptr_of_this_method;
    // 只有一个参数, 所以返回指针就是当前栈指针 ESP - 1
    StackObject* __ret = ILIntepreter.Minus(__esp, 1);
    // 第一个参数为 ESP - 1, 第二个参数为 ESP - 2, 以此类推
    ptr_of_this_method = ILIntepreter.Minus(__esp, 1);
    // 获取参数 message 的值
    object message = StackObject.ToObject(ptr_of_this_method, __domain, __mStack);
    // 需要清理堆栈
    __intp.Free(ptr_of_this_method);
    // 如果参数类型是基础类型, 例如 int, 可以直接通过 int param = ptr_of_this_method->Value 获取值,
    // 关于具体原理和其他基础类型如何获取, 请参考 ILRuntime 实现原理的文档。

    // 通过 ILRuntime 的 Debug 接口获取调用热更 DLL 的堆栈
    string stackTrace = __domain.DebugService.GetStackTrace(__intp);
    Debug.Log(string.Format("{0}\n{1}", format, stackTrace));
    return __ret;
}

```

- **LitJson 集成:** Json 序列化是开发中非常经常需要用到的功能, 考虑到其通用性, 因此 ILRuntime 对 LitJson 这个序列化库进行了集成

```

//对 LitJson 进行注册, 需要在注册 CLR 绑定之前
LitJson.JsonMapper.RegisterILRuntimeCLRRedirection(appdomain);
//LitJson 使用
//将一个对象转换成 json 字符串
string json = JsonMapper.ToJson(obj);
//json 字符串反序列化成对象
JsonTestClass obj = JsonMapper.ToObject<JsonTestClass>(json);

```

- **ILRuntime 的性能优化**

- 值类型优化: 使用 ILRuntime 外部定义的值类型 (例如 UnityEngine.Vector3) 在默认情况下会造成额外的装箱拆箱开销。ILRuntime 在 1.3.0 版中增加了值类型绑定 (ValueTypeBinding) 机制, 通过对这些值类型添加绑定器, 可以大幅增加值类型的执行效率, 以及避免 GC Alloc 内存分配。
- 大规模数值计算: 如果在热更内需要进行大规模数值计算, 则可以开启 ILRuntime 在 2.0 版中加入的寄存器模式来进行优化
- 避免使用 foreach: 尽量避免使用 foreach, 会不可避免地产生 GC。而 for 循环不会。
- 加载 dll 并在逻辑后处理进行简单调用
- 整个文件流程: 创建 IEnumerator 并运行-> 用文件流判断并读入 dll 和 pdb-> 尝试加载程序集 dll-> (如果加载成功) 初始化脚本引擎 (InitializeILRuntime()) -> 执行脚本引擎加载后的逻辑处理 (OnHotFixLoaded()) -> 程序销毁 (在 OnDestroy 中关闭 dll 和 pdb 的文件流)
- MemoryStream: 为系统提供流式读写。MemoryStream 类封装一个字节数组, 在构造实例时可以使用一个字节数组作为参数, 但是数组的长度无法调整。使用默认无参数构造函数创建实例, 可以使用 Write 方法写入, 随着字节数据的写入, 数组的大小自动调整。参考博客: 传送门

- `appdomain.LoadAssembly`: 将需要热更的 dll 加载到解释器中。第一个填入 dll 以及 pdb, 这里的 pdb 应该是 dll 对应的一些标志符号。后面的 `ILRuntime.Mono.Cecil.Pdb.PdbReaderProvider` 是动态修改程序集, 它的作用是给 `ILRuntime.Mono.Cecil.Pdb.PdbReaderProvider()` 里的 `GetSymbolReader()` (传入两个参数, 一个是通过转化后的 `ModuleDefinition.ReadModule(stre` (即 dll) ) 模块定义, 以及原来的 symbol (即 pdb) `GetSymbolReader` 主要的作用是检测其中的一些符号和标志是否为空, 不为空的话就进行读取操作。(这些内容都是 `ILRuntime` 中的文件来完成)
- Unity MonoBehaviour lifecycle methods callback execute orders:
- 还有一个看起来不怎么清楚的, 将就凑合着看一下: 这几个图因为文件地址错误丢了, 改天再补一下
- IL 热更优点:
  - 1、无缝访问 C# 工程的现成代码, 无需额外抽象脚本 API
  - 2、直接使用 VS2015 进行开发, `ILRuntime` 的解译引擎支持 .Net 4.6 编译的 DLL
  - 3、执行效率是 L# 的 10-20 倍
  - 4、选择性的 CLR 绑定使跨域调用更快速, 绑定后跨域调用的性能能达到 slua 的 2 倍左右 (从脚本调用 `GameObject` 之类的接口)
  - 5、支持跨域继承 (代码里的完美学演示)
  - 6、完整的泛型支持 (代码里的完美学演示)
  - 7、拥有 Visual Studio 的调试插件, 可以实现真机源码级调试。支持 Visual Studio 2015 Update3 以及 Visual Studio 2017 和 Visual Studio 2019
  - 8、最新的 2.0 版引入的寄存器模式将数学运算性能进行了大幅优化

## 4.4 ILRuntime 启动调试

- `ILRuntime` 建议全局只创建一个 `AppDomain`, 在函数入口添加代码启动调试服务

```
appdomain.DebugService.StartDebugService(56000)
```

- 运行主工程 (Unity 工程)
- 在热更的 VS 工程中点击 - 调试 - 附加到 `ILRuntime` 调试, 注意使用一样的端口
- 如果使用 VS2015 的话需要 Visual Studio 2015 Update3 以上版本

## 4.5 线上项目和资料

- 掌趣很多项目都是使用 `ILRuntime` 开发, 并上线运营, 比如: 真红之刃, 境·界灵压对决, 全民奇迹 2, 龙族世界, 热血足球
- 初音未来: 梦幻歌姬使用补丁方式: <https://github.com/wuxiongb/XIL>
- 本文流程图摘自: `ILRuntime` 的 QQ 群的《`ILRuntime` 热更框架.docx》(by a 704757217)
- Unity 实现 c# 热更新方案探究 (三): <https://zhuanlan.zhihu.com/p/37375372>



## 5 Framework.Core 核心理解：现在有足足的干劲把 ILRuntime + MVVM 热更新框架里的方方面面都理解消化透彻！爱表哥爱生活

### 5.1 Adaptor

#### 5.1.1 IDisposableAdaptor : CrossBindingAdaptor

```
public class IDisposableAdaptor : CrossBindingAdaptor {
// 实现基类里所定义的三个方法
    public override Type BaseCLRType {
        get {
            return typeof(IDisposable);
        }
    }
    public override Type AdaptorType {
        get {
            return typeof(Adaptor);
        }
    }
    public override object CreateCLRInstance(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
        return new Adaptor(appdomain, instance);
    }

    internal class Adaptor : IDisposable, CrossBindingAdaptorType {
        ILTypeInstance instance; // 基类 CrossBindingAdaptorType 里所必须有的一个实例
        ILRuntime.Runtime.Environment.AppDomain appdomain;

        public Adaptor() { }
        public Adaptor(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
            this.appdomain = appdomain;
            this.instance = instance;
        }
        public ILTypeInstance ILInstance { get { return instance; } } // getter

        IMethod _Dispose;
        public void Dispose() {
            if (_Dispose == null)
                _Dispose = instance.Type.GetMethod("Dispose", 0);
            if (_Dispose != null)
                appdomain.Invoke(_Dispose, instance);
        }
    }
}
```

#### 5.1.2 IEnumeratorObjectAdaptor : CrossBindingAdaptor { // 叠代器适配器？不是集合元素里轮询的叠代器，而是协程

```
public class IEnumeratorObjectAdaptor : CrossBindingAdaptor {
// 基类里的三个方法的实现
    public override Type BaseCLRType {
        get {
            return typeof(IEnumerator<object>);
        }
    }
    public override Type AdaptorType {
        get {
            return typeof(Adaptor);
        }
    }
    public override object CreateCLRInstance(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
        return new Adaptor(appdomain, instance);
    }

// 这些个 IXxxxx IEnumerator<T> 之类的，是在哪里定义的，还是说是 C #语言里本来就有的呢？
// 弄不明白的这些个以 I 打头的：都定义在 plugins 里的 ILRuntime 的包裹里，改天可以一一再看一下
    internal class Adaptor : IEnumerator<object>, CrossBindingAdaptorType {
        ILTypeInstance instance;
        ILRuntime.Runtime.Environment.AppDomain appdomain;

        public Adaptor() { }
        public Adaptor(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
            this.appdomain = appdomain;
        }
    }
}
```



```

        this.instance = instance;
        _get_Current = instance.Type.GetMethod(".get_Current", 0);
    }

    public ILTypeInstance ILInstance { get { return instance; } } // getter

    public object Current { // 叠代器适配器所特有的方法，当前元素
        get {
            var obj = appdomain.Invoke(_get_Current, null);
            return obj;
        }
    }
}

// 这里的几个方法，是因为协程需要用到，所以不得不定义的吗？还有什么基类之类的吗？
IMethod _MoveNext;
IMethod _get_Current;
IMethod _Reset;
IMethod _Dispose;
public bool MoveNext() {
    if (_MoveNext == null)
        _MoveNext = instance.Type.GetMethod("MoveNext", 0);
    if (_MoveNext != null)
        return (bool)appdomain.Invoke(_MoveNext, instance);
    return false;
}
public void Reset() {
    if (_Reset == null)
        _Reset = instance.Type.GetMethod("MoveNext", 0);
    if (_Reset != null)
        appdomain.Invoke(_Reset, instance);
}
public void Dispose() {
    if (_Dispose == null)
        _Dispose = instance.Type.GetMethod("Dispose", 0);
    if (_Dispose != null)
        appdomain.Invoke(_Dispose, instance);
}
}
}
}

```

### 5.1.3 InterfaceCrossBindingAdaptor : CrossBindingAdaptor: 就是实现基类里的三个方法呀

```

public class InterfaceCrossBindingAdaptor : CrossBindingAdaptor { // 就是实现基类里的三个方法呀
    public override Type BaseCLRType {
        get {
            return typeof(IEnumerator);
        }
    }
    public override Type AdaptorType {
        get {
            return typeof(IEnumeratorObjectAdaptor.Adaptor);
        }
    }
    public override object CreateCLRInstance(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
        return new IEnumeratorObjectAdaptor.Adaptor(appdomain, instance);
    }
}

```

### 5.1.4 MonoBehaviourAdapter : CrossBindingAdaptor: ./Plugins/ILRuntime/Adapters包裹里的

```

// ./Plugins/ILRuntime/Adapters/MonoBehaviourAdapter.cs: 注意这个程序所在的包裹
public class MonoBehaviourAdapter : CrossBindingAdaptor {
    // 实现基类里的三个抽象方法
    public override Type BaseCLRType {
        get {
            return typeof(MonoBehaviour);
        }
    }
    public override Type AdaptorType {
        get {
            return typeof(Adaptor);
        }
    }
    public override object CreateCLRInstance(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {

```

```

        return new Adaptor(appdomain, instance);
    }

// 为了完整实现 MonoBehaviour 的所有特性, 这个 Adapter 还得扩展, 这里只抛砖引玉, 只实现了最常用的 Awake, Start 和 Update
// 像我很熟悉的安卓 Activity/Fragment 的生命周期有很多回调方法一样, MonoBehaviour 也有好几个生命周期回调方法可供实现扩展
public class Adaptor : MonoBehaviour, CrossBindingAdaptorType {
    ILTypeInstance instance;
    ILRuntime.Runtime.Environment.AppDomain appdomain;

    public Adaptor() { }
    public Adaptor(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
        this.appdomain = appdomain;
        this.instance = instance;
    }

    public ILTypeInstance ILInstance { get { return instance; } set { instance = value; } }
    public ILRuntime.Runtime.Environment.AppDomain AppDomain { get { return appdomain; } set { appdomain = value; } }

// Awake() Start() Update() 三个生命周期架设方法的跨域适配
    IMethod mAwakeMethod;
    bool mAwakeMethodGot;
    public void Awake() {
        // Unity 会在 ILRuntime 准备好这个实例前调用 Awake, 所以这里暂时先不掉用
        if (instance != null) {
            if (!mAwakeMethodGot) {
                mAwakeMethod = instance.Type.GetMethod("Awake", 0);
                mAwakeMethodGot = true;
            }
            if (mAwakeMethod != null) {
                appdomain.Invoke(mAwakeMethod, instance, null);
            }
        }
    }

    IMethod mStartMethod;
    bool mStartMethodGot;
    void Start() {
        if (!mStartMethodGot) {
            mStartMethod = instance.Type.GetMethod("Start", 0);
            mStartMethodGot = true;
        }
        if (mStartMethod != null) {
            appdomain.Invoke(mStartMethod, instance, null);
        }
    }

    IMethod mUpdateMethod;
    bool mUpdateMethodGot;
    void Update() {
        if (!mUpdateMethodGot) {
            mUpdateMethod = instance.Type.GetMethod("Update", 0);
            mUpdateMethodGot = true;
        }
        if (mStartMethod != null) {
            appdomain.Invoke(mUpdateMethod, instance, null);
        }
    }

    public override string ToString() {
        IMethod m = appdomain.ObjectType.GetMethod("ToString", 0);
        m = instance.Type.GetVirtualMethod(m);
        if (m == null || m is IMethod) {
            return instance.ToString();
        } else {
            return instance.Type.FullName;
        }
    }
}
}

```

## 5.2 Factory: 顾名思义, 就是工厂模式, 负责生产各种不同类型的实例 (生产人质)

### 5.2.1 enum FactoryType

```

public enum FactoryType {
    Singleton,
    Transient,
    Pool
}

```

## 5.2.2 interface IObjectFactory

```
public interface IObjectFactory {
    object AcquireObject(string classFullName);
    void ReleaseObject(object obj);
}
```

## 5.2.3 PoolObjectFactory : Singleton<PoolObjectFactory>, IObjectFactory: 单例对象池: 结合工厂模式使用

// 单例对象池: 结合工厂模式使用; 现接触过的对象池包括 *ThreadPool*, *ObjectPool*,  
**public class PoolObjectFactory** : Singleton<PoolObjectFactory>, IObjectFactory {

```
    public class ObjectPool {
        public readonly List<PoolData> _pool; // readonly
        public int Max { // 该对象池储存数据上限
            get;
            set;
        }
        public bool Limit { // 该对象池设限了吗?
            get;
            set;
        }
        public ObjectPool() {
            Limit = false;
            _pool = new List<PoolData>();
        }
    }
    public class PoolData {
        public bool InUse {
            get;
            set;
        }
        public object Obj {
            get;
            set;
        }
    }
}
// 这里, 每种类型对应一个对象池 (因为每种类型根据游戏需要可能初始化数量等不同有不同的要求), 用一个字典管理不同类型的对象池
private readonly Dictionary<Type, ObjectPool> pool;
public PoolObjectFactory() {
    pool = new Dictionary<Type, ObjectPool>();
}

public object AcquireObject(string classFullName) {
    Type type = GameApplication.Instance.HotFix.LoadType(classFullName);
    lock (pool) { // 这里需要上锁
        if (pool.ContainsKey(type)) {
            if (pool[type]._pool.Count > 0) {
                for (int i = 0; i < pool[type]._pool.Count; i++) {
                    var p = pool[type]._pool[i];
                    if (!p.InUse) { // 从该类型对象池里的现有对象链表中遍历出第一个没被使用的对象拿来用
                        p.InUse = true;
                        return p.Obj;
                    }
                }
            }
            // 该类型对象池数量已经达到了上限
            if (pool[type].Limit && pool[type]._pool.Count >= pool[type].Max)
                throw new Exception("max limit is arrived.");
        }
        object obj = GameApplication.Instance.HotFix.CreateInstance(classFullName);
        var poolData = new PoolData {
            InUse = true,
            Obj = obj
        };
        if (!pool.ContainsKey(type)) {
            ObjectPool objPool = new ObjectPool();
            pool.Add(type, objPool);
        }
        pool[type]._pool.Add(poolData);
        return obj;
    }
}
public void ReleaseObject(object obj) { }
```

## 5.2.4 SingletonObjectFactory : IObjectFactory: 单例对象工厂

// 单例对象工厂

```
public class SingletonObjectFactory : IObjectFactory {

    private static Dictionary<Type, object> cachedObjects = null;
    private static readonly object _lock = new object();

    private Dictionary<Type, object> CachedObjects {
        get {
            lock (_lock) {
                if (cachedObjects == null)
                    cachedObjects = new Dictionary<Type, object>();
                return cachedObjects;
            }
        }
    }

    public object AcquireObject(string classFullName) {
        Type type = GameApplication.Instance.HotFix.LoadType(classFullName);
        if (CachedObjects.ContainsKey(type))
            return CachedObjects[type];
        lock (_lock) {
            var instance = GameApplication.Instance.HotFix.CreateInstance(classFullName);
            CachedObjects.Add(type, instance);
            return instance;
        }
    }

    public void ReleaseObject(object obj) { }
}
```

## 5.2.5 TransientObjectFactory : IObjectFactory

```
public class TransientObjectFactory : IObjectFactory {

    public object AcquireObject(string classFullName) {
        var instance = GameApplication.Instance.HotFix.CreateInstance(classFullName);
        return instance;
    }

    public void ReleaseObject(object obj) { }
}
```

## 5.3 Inject: 每个（自动）注入的背后，都是强大优化过的逻辑在支撑！爱表哥，爱生活

- 每个看似此情只该天上有何在发生在人间的神仙着侣故事背后都有着别人三生三世的守候相亲相爱和相互理解与付出做支撑，爱表哥，爱生活!!!

### 5.3.1 ServiceLocatorContain

```
public class ServiceLocatorContain {
    public string TypeName {
        get;
        private set;
    }
    public Func<object> Function {
        get;
        set;
    }
}

public ServiceLocatorContain(string name, Func<object> func) {
    TypeName = name;
    Function = func;
}

// 对象定位（创建）工厂：要么去对象池里抓一下；（当没有或是所有对象均在用且达上限）要么创建一个新的
public class ServiceLocator {
    private static readonly Dictionary<Type, ServiceLocatorContain> Container = new Dictionary<Type, ServiceLocatorContain>();

    // 两种不同类型的工厂以及对象的定位方法（每种类型提供两种不同参数的定位方法）
    private SingletonObjectFactory _singletonObjectFactory = new SingletonObjectFactory();
    private TransientObjectFactory _transientObjectFactory = new TransientObjectFactory();

    // 两种不同类型的工厂以及对象的定位方法（每种类型提供两种不同参数的定位方法）
    public void RegisterSingleton(string interfaceName, string typeName) {
```

```

        ServiceLocatorContain contain = new ServiceLocatorContain(typeName, Lazy(FactoryType.Singleton, typeName));
        Type type = GameApplication.Instance.HotFix.LoadType(interfaceName);
        if (!Container.ContainsKey(type)) {
            Container.Add(type, contain);
        } else {
            throw new Exception("Container contains key: " + type);
        }
    }

    public void RegisterSingleton(string typeName) {
        ServiceLocatorContain contain = new ServiceLocatorContain(typeName, Lazy(FactoryType.Singleton, typeName));
        Type type = GameApplication.Instance.HotFix.LoadType(typeName);
        if (!Container.ContainsKey(type)) {
            Container.Add(type, contain);
        } else {
            throw new Exception("Container contains key: " + type);
        }
    }

    public void RegisterTransient(string interfaceName, string typeName) {
        ServiceLocatorContain contain = new ServiceLocatorContain(typeName, Lazy(FactoryType.Transient, typeName));
        Type type = GameApplication.Instance.HotFix.LoadType(interfaceName);
        if (!Container.ContainsKey(type)) {
            Container.Add(type, contain);
        } else {
            throw new Exception("Container contains key: " + type);
        }
    }

    public void RegisterTransient(string typeName) {
        ServiceLocatorContain contain = new ServiceLocatorContain(typeName, Lazy(FactoryType.Transient, typeName));
        Type type = GameApplication.Instance.HotFix.LoadType(typeName);
        if (!Container.ContainsKey(type)) {
            Container.Add(type, contain);
        } else {
            throw new Exception("Container contains key: " + type);
        }
    }

    public void Clear() {
        Container.Clear();
    }

    public TInterface Resolve<TInterface>(string keyName) where TInterface : class {
        return Resolve(GameApplication.Instance.HotFix.LoadType(keyName)) as TInterface;
    }

    private static object Resolve(Type type) {
        if (!Container.ContainsKey(type))
            return null;
        return Container[type].Function();
    }

    private Func<object> Lazy(FactoryType factoryType, string typeFullName) {
        return () => {
            switch (factoryType) {
                case FactoryType.Singleton:
                    return _singletonObjectFactory.AcquireObject(typeFullName);
                default:
                    return _transientObjectFactory.AcquireObject(typeFullName);
            }
        };
    }
}

```

## 5.4 Wrap

## 5.5 GameApplication: 游戏入口类

```

// 游戏入口类
public class GameApplication : MonoBehaviour {
    private const string TAG = "GameApplication";

    private static GameApplication _instance;
    public static GameApplication Instance {
        get {
            return _instance;
        }
    }

    public IHotFixMain HotFix {
        get;
        set;
    }
}

```

```

// 五个用户、客户端可配置变量，以及它们的根据用户配置（读取系统中用户配置文件里的相关五个配置）
// 是否使用 PDB 调试信息
public bool usePDB = false;
// 是否使用 ILRuntime 模式热更新
public bool useILRuntime = false;
// 是否使用本地资源
public bool useLocal = false;
// 资源服务器路径
public string webRoot = string.Empty;
// 强制登录
public bool forceLogin = false;

public ScreenRaycaster ScreenRaycaster {
    get;
    private set;
}
}

// 这个公用方法应该是跟游戏中时常需要接入一个或是多个游戏 SDK 相关，提供便利接入方法
public ShareSDK ShareSDK {
    get;
    private set;
}

void Awake() {
    _instance = this;
    ScreenRaycaster = GameObject.Find("Gestures").GetComponent<ScreenRaycaster>();
    DontDestroyOnLoad(gameObject); // <===== 我自己的游戏中实现过这个，可是现在回想得好辛苦呀。。爱表哥爱生活
    //InitializeClientConfig();
    //InitializeSDKs();
    CoroutineHelper.StartCoroutine(Initialize()); // 协程：
#region TestSamples
    //FingerEventTemp.Instance.RegisterGestureEvents();
    //TestNTS.Instance.TestLinesAngle();
    //GeometryManager.Instance.Test();
#endregion
}

// 客户端的配置是写在一个文件里的，需要的话直接读就可以了，安卓系统很多地方也这样
void InitializeClientConfig() {
    var str = FileHelp.ReadString("ClientConfig.txt");
    if (!string.IsNullOrEmpty(str)) {
        JsonObject jsonObject = JsonSerializer.Deserialize(str) as JsonObject;
        if (jsonObject != null) {
            if (jsonObject.ContainsKey("usePDB"))
                usePDB = (bool)jsonObject["usePDB"];
            if (jsonObject.ContainsKey("useILRuntime"))
                usePDB = (bool)jsonObject["useILRuntime"];
            if (jsonObject.ContainsKey("useLocal"))
                usePDB = (bool)jsonObject["useLocal"];
            if (jsonObject.ContainsKey("webRoot"))
                ResourceConstant.ResourceWebRoot = jsonObject["webRoot"].ToString();
            if (jsonObject.ContainsKey("forceLogin"))
                forceLogin = (bool)jsonObject["forceLogin"];
        }
    }
}

void InitializeSDKs() {
    if (Application.platform == RuntimePlatform.IPhonePlayer || Application.platform == RuntimePlatform.Android)
        InitializeShareSDK();
}

void InitializeShareSDK() {
    ShareSDK = GetComponent<ShareSDK>();
    ShareSDK.authHandler = AuthResultHandler;
    ShareSDK.Authorize(PlatformType.WeChat);
}

// ShareSDK 执行授权回调
void AuthResultHandler(int reqID, ResponseState state, PlatformType type, Hashtable result) {
    if (state == ResponseState.Success) {
        Debug.Log("ShareSDK authorize success!");
    } else if (state == ResponseState.Fail) {
        Debug.Log("fail! error code = " + result["error_code"] + "; error msg = " + result["error_msg"]);
    } else if (state == ResponseState.Cancel) {
        Debug.Log("cancel!");
    }
}

// 协程是说：游戏启动时，给这个控件 (gameObject) 加载运行时元件 ResourceMap (本质上是脚本程序)；加载完毕自动触发 StartHotFix()
IEnumerator Initialize() {
    ResourceMap resourceMap = gameObject.AddComponent<ResourceMap>();
    resourceMap.OnInitializeSuccess += StartHotFix;
}

```

```

        ResourceConstant.Loader = resourceMap;
        yield return new WaitForEndOfFrame();
    }
    public void StartHotFix() {
        Debug.Log(TAG + ": StartHotFix()");
        Debug.Log(TAG + " useILRuntime: " + useILRuntime);
        if (Application.platform == RuntimePlatform.IPhonePlayer) {
            HotFix = HotFixILRunTime.Instance;
        } else {
            if (useILRuntime) { // 使用热更新程序集的实例
                HotFix = HotFixILRunTime.Instance;
            } else { // 这里是，还需要再理解消化一下
                HotFix = HotFixReflector.Instance;
            }
        }
    }
}
}
}

```

## 5.6 HotFixILRunTime : SingletonMono<HotFixILRunTime>, IHotFixMain: 因为跨域交互，所以即使是热更新包，也继承自 unity MonoBehaviour

```

public class HotFixILRunTime : SingletonMono<HotFixILRunTime>, IHotFixMain { // SingletonMono<T> where T : MonoBehaviour 帮
    public static ILRuntime.Runtime.Environment.AppDomain appDomain;

    void Start() {
        appDomain = new ILRuntime.Runtime.Environment.AppDomain();
    }
    #if UNITY_EDITOR
        appDomain.UnityMainThreadID = System.Threading.Thread.CurrentThread.ManagedThreadId;
    #endif

    // 调用资源管理器加载这两个程序集: HotFix.dll + HotFix.pdb
    TextAsset dllAsset = ResourceConstant.Loader.LoadAsset<TextAsset>("HotFix.dll", "HotFix.dll"); // 同步加载
    var msDll = new System.IO.MemoryStream(dllAsset.bytes); // 这里涉及到内存管理吗？以前我不曾涉及，现在长大了，应该把它理
    if (GameApplication.Instance.usePDB) {
        ResourceConstant.Loader.LoadAssetAsync<TextAsset>("HotFix.pdb", "HotFix.pdb", (pdbAsset) => { // 异步加载
            var msPdb = new System.IO.MemoryStream(pdbAsset.bytes);
            appDomain.LoadAssembly(msDll, msPdb, new Mono.Cecil.Mdb.MdbReaderProvider());
            StartApplication(); // <-----
        }, EAssetBundleUnloadLevel.ChangeSceneOver);
    } else {
        appDomain.LoadAssembly(msDll, null, new Mono.Cecil.Mdb.MdbReaderProvider());
        StartApplication();
    }
}

void StartApplication() {
    InitializeILRunTimeHotFixSetting();
    DoStaticMethod("HotFix.HotFixMain", "Start");
}

void InitializeILRunTimeHotFixSetting() {
    InitializeDelegateSetting(); // 方法被我搬到了文件的最后，太长比较简单
    InitializeCLRBindSetting();
    InitializeAdapterSetting();
    InitializeValueTypeSetting();
}

unsafe void InitializeCLRBindSetting() {
    foreach (var i in typeof(System.Activator).GetMethods()) {
        // 找到名字为 CreateInstance，并且是泛型方法的方法定义？
        if (i.Name == "CreateInstance" && i.IsGenericMethodDefinition)
            appDomain.RegisterCLRMethodRedirection(i, CreateInstance); // 方法重定向？再理解消化一下，不太懂还
    }
}

void InitializeAdapterSetting() {
    appDomain.RegisterCrossBindingAdaptor(new ViewModelBaseAdaptor());
    appDomain.RegisterCrossBindingAdaptor(new UnityGuiViewAdaptor());
    appDomain.RegisterCrossBindingAdaptor(new ModuleBaseAdaptor());
    appDomain.RegisterCrossBindingAdaptor(new IEnumeratorObjectAdaptor()); // 协程适配
    appDomain.RegisterCrossBindingAdaptor(new MonoBehaviourAdaptor()); // <----- 临时补了一下，也有了
    appDomain.RegisterCrossBindingAdaptor(new InterfaceCrossBindingAdaptor());
}

void InitializeValueTypeSetting() {
    appDomain.RegisterValueTypeBinder(typeof(Vector3), new Vector3Binder());
    appDomain.RegisterValueTypeBinder(typeof(Vector2), new Vector2Binder());
    appDomain.RegisterValueTypeBinder(typeof(Quaternion), new QuaternionBinder());
}
}

```



```

// 定义如何调用热更新程序集里的静态入口方法
object DoStaticMethod(string type, string method) {
    var hotfixType = appDomain.GetType(type);
    var staticMethod = hotfixType.GetMethod(method, 0);
    return appDomain.Invoke(staticMethod, null, null);
}

// 定义热更新的两个方法的特用实现
#region Override
public Type LoadType(string typeName) {
    if (appDomain.LoadedTypes.ContainsKey(typeName)) {
        return appDomain.LoadedTypes[typeName].ReflectionType;
    }
    return null;
}
public object CreateInstance(string typeName) {
    ILType type = (ILType)appDomain.LoadedTypes[typeName];
    var instance = type.Instantiate();
    return instance;
}
#endregion

// 公用静态方法的实现
public unsafe static StackObject* CreateInstance(ILIntepreter intp, StackObject* esp, IList<object> mStack, CLRMethod m)
// 获取泛型参数 <T> 的实际类型
IType[] genericArguments = method.GenericArguments;
if (genericArguments != null && genericArguments.Length == 1) {
    var t = genericArguments[0];
    if (t is ILType) // 如果 T 是热更 DLL 里的类型 {
        // 通过 ILRuntime 的接口来创建实例
        return ILIntepreter.PushObject(esp, mStack, ((ILType)t).Instantiate());
    } else
        return ILIntepreter.PushObject(esp, mStack, Activator.CreateInstance(t.TypeForCLR)); // 通过系统反射接口创建实例
} else
    throw new EntryPointNotFoundException();
}

// 不准猜测理解：所有需要热更新的方法类型（以不同的参数类型以及返回类型作区分），都要在这里向程序集的代理管理器注册相关方法回调代理
// 同一参数组合只需要注册一次
void InitializeDelegateSetting() { // 注册，不带返回值，最多支持五个参数传入；注册，带参数返回值，最后一个参数为返回值，最多支持
    appDomain.DelegateManager.RegisterMethodDelegate<int>();
    appDomain.DelegateManager.RegisterFunctionDelegate<int, string>();
    appDomain.DelegateManager.RegisterMethodDelegate<string>();
    appDomain.DelegateManager.RegisterMethodDelegate<int, int>();
    appDomain.DelegateManager.RegisterMethodDelegate<List<int>, List<int>>();
    appDomain.DelegateManager.RegisterMethodDelegate<string, string>();
    appDomain.DelegateManager.RegisterMethodDelegate<object, MessageArgs<object>>();
    appDomain.DelegateManager.RegisterMethodDelegate<object, MessageArgs<ILTypeInstance>>();
    appDomain.DelegateManager.RegisterMethodDelegate<GameObject>();
    appDomain.DelegateManager.RegisterMethodDelegate<UnityEngine.Networking.UnityWebRequest>();
    appDomain.DelegateManager.RegisterMethodDelegate<TMP_FontAsset>();
    appDomain.DelegateManager.RegisterMethodDelegate<Font>();
    appDomain.DelegateManager.RegisterMethodDelegate<AnimationClip>();
    appDomain.DelegateManager.RegisterMethodDelegate<AnimatorOverrideController>();
    appDomain.DelegateManager.RegisterMethodDelegate<RuntimeAnimatorController>();
    appDomain.DelegateManager.RegisterMethodDelegate<AudioClip>();
    appDomain.DelegateManager.RegisterMethodDelegate<Material>();
    appDomain.DelegateManager.RegisterMethodDelegate<Texture2D>();
    appDomain.DelegateManager.RegisterMethodDelegate<Sprite>();
    appDomain.DelegateManager.RegisterMethodDelegate<Texture2D>();
    appDomain.DelegateManager.RegisterMethodDelegate<TapGesture>();
    appDomain.DelegateManager.RegisterMethodDelegate<LongPressGesture>();
    appDomain.DelegateManager.RegisterMethodDelegate<DragGesture>();
    appDomain.DelegateManager.RegisterMethodDelegate<PinchGesture>();
    appDomain.DelegateManager.RegisterMethodDelegate<Exception>();
    appDomain.DelegateManager.RegisterFunctionDelegate<GameObject, GameObject>();
    appDomain.DelegateManager.RegisterFunctionDelegate<ILTypeInstance, ILTypeInstance, int>();
}

// 在 Unity 的程序集与热更新的程序集跨域之间，这里给出了方法代理转换的实现逻辑，几座小桥流水人家，爱表哥爱生活
// 委托转换器：需要将一个不是 Action 或者 Func 类型的委托实例传到 ILRuntime 外部使用，需要写委托适配器和委托转换器。
// 委托转换器将 Action 和 Func 转换成你真正需要的那个委托类型
// 为了避免不必要的麻烦，以及后期热更出现问题，建议： 1、尽量避免不必要的跨域委托调用 2、尽量使用 Action 以及 Func 委托类型
appDomain.DelegateManager.RegisterDelegateConvertor<UnityAction>((action) => {
    return new UnityAction(() => {
        ((Action)action)();
    });
});
appDomain.DelegateManager.RegisterDelegateConvertor<UnityAction<bool>>((action) => {
    return new UnityAction<bool>((b) => {
        ((Action<bool>)action)(b);
    });
});

```

```

    });
});
appDomain.DelegateManager.RegisterDelegateConvertor<UnityAction<int>>((action) => {
    return new UnityAction<int>((b) => {
        ((Action<int>)action)(b);
    });
});
appDomain.DelegateManager.RegisterDelegateConvertor<UnityAction<long>>((action) => {
    return new UnityAction<long>((b) => {
        ((Action<long>)action)(b);
    });
});
appDomain.DelegateManager.RegisterDelegateConvertor<UnityAction<float>>((action) => {
    return new UnityAction<float>((b) => {
        ((Action<float>)action)(b);
    });
});
appDomain.DelegateManager.RegisterDelegateConvertor<UnityAction<string>>((action) => {
    return new UnityAction<string>((b) => {
        ((Action<string>)action)(b);
    });
});
appDomain.DelegateManager.RegisterDelegateConvertor<UnityAction<BaseEventData>>((action) => {
    return new UnityAction<BaseEventData>((b) => {
        ((Action<BaseEventData>)action)(b);
    });
});
appDomain.DelegateManager.RegisterDelegateConvertor<GestureRecognizerTS<TapGesture>.GestureEventHandler>((action) => {
    return new GestureRecognizerTS<TapGesture>.GestureEventHandler((gesture) => {
        ((Action<TapGesture>)action)(gesture);
    });
});
appDomain.DelegateManager.RegisterDelegateConvertor<GestureRecognizerTS<LongPressGesture>.GestureEventHandler>((action) => {
    return new GestureRecognizerTS<LongPressGesture>.GestureEventHandler((gesture) => {
        ((Action<LongPressGesture>)action)(gesture);
    });
});
appDomain.DelegateManager.RegisterDelegateConvertor<GestureRecognizerTS<DragGesture>.GestureEventHandler>((action) => {
    return new GestureRecognizerTS<DragGesture>.GestureEventHandler((gesture) => {
        ((Action<DragGesture>)action)(gesture);
    });
});
appDomain.DelegateManager.RegisterDelegateConvertor<GestureRecognizerTS<PinchGesture>.GestureEventHandler>((action) => {
    return new GestureRecognizerTS<PinchGesture>.GestureEventHandler((gesture) => {
        ((Action<PinchGesture>)action)(gesture);
    });
});
#if UNITY_IPHONE
    appDomain.DelegateManager.RegisterDelegateConvertor<com.mob.FinishedRecordEvent>((action) => {
        return new com.mob.FinishedRecordEvent((ex) => {
            ((Action<Exception>)action)(ex);
        });
    });
#endif
appDomain.DelegateManager.RegisterDelegateConvertor<Comparison<ILTypeInstance>>((action) => {
    return new Comparison<ILTypeInstance>((x, y) => {
        return ((Func<ILTypeInstance, ILTypeInstance, System.Int32>)action)(x, y);
    });
});
}
}

```

## 5.7 HotFixReflector : SingletonMono<HotFixReflector>, IHotFixMain

```

public class HotFixReflector : SingletonMono<HotFixReflector>, IHotFixMain {
    public static Assembly assembly;

    void Start() {
        ResourceConstant.Loader.LoadAssetAsync<TextAsset>( // 这里说是异步加载
            "HotFix.dll", "HotFix.dll",
            LoadHotFixDllSuccess,
            EAssetBundleUnloadLevel.ChangeSceneOver);
    }

    void LoadHotFixDllSuccess(TextAsset dllAsset) {
        if (GameApplication.Instance.usePDB) {
            ResourceConstant.Loader.LoadAssetAsync<TextAsset>( // 同样是异步加载

```

```

        "HotFix.pdb",
        "HotFix.pdb", (pdbAsset) => {
            assembly = Assembly.Load(dllAsset.bytes, pdbAsset.bytes);
            StartApplication(); // <<<<<<<<<<
        }, EAssetBundleUnLoadLevel.ChangeSceneOver);
    } else {
        assembly = AppDomain.CurrentDomain.Load(dllAsset.bytes);
        StartApplication();
    }
}

void StartApplication() {
    try {
        Type hotfixMainType = assembly.GetType("HotFix.HotFixMain");
        MethodInfo startMethod = hotfixMainType.GetMethod("Start");
        startMethod.Invoke(null, null);
    } catch (Exception e) {
        string errorMessage = string.Empty;
        if (e.InnerException != null)
            errorMessage = e.InnerException.Message + e.InnerException.StackTrace;
        else errorMessage = e.Message + e.StackTrace;
        DebugHelper.LogError(errorMessage, true);
    }
}

#region Override
public Type LoadType(string typeName) {
    Type type = assembly.GetType().FirstOrDefault(t => t.FullName == typeName);
    if (type == null) {
        DebugHelper.LogError(string.Format("Can't find Class by class name:'{0}'", typeName), true);
        throw new Exception(string.Format("Can't find Class by class name:'{0}'", typeName));
    }
    return type;
}

public object CreateInstance(string typeName) {
    return Activator.CreateInstance(LoadType(typeName));
}
}
#endregion
}

```

## 5.8 IHotFixMain interface

```

public interface IHotFixMain {
    Type LoadType(string typeName);
    object CreateInstance(string typeName);
}

```

# 6 Framework.MVVM: Unity 中定义好的 MVVM 架构；使用 ILRuntime 定义实现了必要的跨域跨程序集适配，以及数据观察回调等

## 6.1 DataBinding: MVVM 具备双向数据绑定功能；这里这个框架里通过代理观察者模式来实现数据的改变通知与回调

### 6.1.1 BindableProperty<T>：泛型基类，可绑定的属性

```

public class BindableProperty<T> { // 泛型基类
    private T _value;

    public Action<T, T> OnValueChanged; // 代理模式，观察者模式？
    public T Value {
        get {
            return _value;
        }
        set {
            if (!Equals(_value, value)) {
                T old = _value;
                _value = value;
                ValueChanged(old, _value);
            }
        }
    }
}

```

```

    }
    void ValueChanged(T oldValue, T newValue) {
        if (OnValueChanged != null)
            OnValueChanged(oldValue, newValue);
    }

    public override string ToString() {
        return (Value != null ? Value.ToString() : "null");
    }
}

```

### 6.1.2 ObservableList<T> : IList<T> : 可被观察的链表, 同样包装成泛型基类

```
public class ObservableList<T> : IList<T> { // 可被观察的链表：同样包装成泛型基类
```

[illegible]

```

public int IndexOf(T item) {
    return _value.IndexOf(item);
}
public void Insert(int index, T item) {
    _value.Insert(index, item);
    if (OnInsert != null) {
        OnInsert(index, item);
    }
}
public void RemoveAt(int index) {
    _value.RemoveAt(index);
}
public T this[int index] {
    get {
        return _value[index];
    }
    set {
        _value[index] = value;
    }
}
}
}

```

### 6.1.3 PropertyBinder<ViewModelBase>: ViewModel(的基类以及继承类) 的绑定辅助相关方法定义类

// ViewModel(的基类以及继承类) 的绑定辅助相关方法定义类

```

public class PropertyBinder<ViewModelBase> {

    private delegate void BindHandler(ViewModelBase viewModel); // 这里才真正意义上的代理模式吧
    private delegate void UnBindHandler(ViewModelBase viewModel);

    private readonly List<BindHandler> binders = new List<BindHandler>();
    private readonly List<UnBindHandler> unBinders = new List<UnBindHandler>();

    public void Add<TProperty>(string name, string realTypeName, Action<TProperty, TProperty> valueChangedHandler) {
        var fieldInfo = GameApplication.Instance.HotFix.LoadType(realTypeName).GetField(name, BindingFlags.Instance | BindingFlags.NonPublic);
        if (fieldInfo == null)
            throw new Exception(string.Format("Unable to find bindableproperty field '{0}.{1}'", realTypeName, name));
        binders.Add(viewModel => {
            GetPropertyValue<TProperty>(name, viewModel, realTypeName, fieldInfo).OnValueChanged += valueChangedHandler;
        });
        unBinders.Add(viewModel => {
            GetPropertyValue<TProperty>(name, viewModel, realTypeName, fieldInfo).OnValueChanged -= valueChangedHandler;
        });
    }
    private BindableProperty<TProperty> GetPropertyValue<TProperty>(string name, ViewModelBase viewModel,
                                                                    string realTypeName, FieldInfo fieldInfo) {
        var value = fieldInfo.GetValue(viewModel);
        BindableProperty<TProperty> bindableProperty = value as BindableProperty<TProperty>;
        if (bindableProperty == null)
            throw new Exception(string.Format("Illegal bindableproperty field '{0}.{1}' ", realTypeName, name));
        return bindableProperty;
    }

    // 这里告诉一个常识说: 任何一个 ViewModel, 不管是基类还是继承后的子类, 它们都有可能有好几个视图与其绑定
    public void Bind(ViewModelBase viewModel) {
        if (viewModel != null)
            for (int i = 0; i < binders.Count; i++)
                binders[i](viewModel);
    }
    // 这里告诉一个常识说: 任何一个 ViewModel, 不管是基类还是继承后的子类, 它们都有可能有好几个视图, 需要与其解绑定
    public void UnBind(ViewModelBase viewModel) {
        if (viewModel != null)
            for (int i = 0; i < unBinders.Count; i++)
                unBinders[i](viewModel);
    }
}

```

## 6.2 Message: 自定义的消息机制吗？这里还没能联系上下文，完全不知道这里是在做什么？

### 6.2.1 MessageArgs<T>: 跨域跨程序集的消息参数泛型类？

```
public class MessageArgs<T> {
    public T Item {
        get;
        private set;
    }
    public MessageArgs(T item) {
        Item = item;
    }
}
```

### 6.2.2 MessageAggregator<T> : Singleton<MessageAggregator<T>>: 单例模式的泛型管理类？用一个字典来管理消息？

// 单例模式的泛型管理类？用一个字典来管理消息（可观察的属性、链表、ViewModel 等，以及它们各自对应的回调）？这里要再看一遍，还没有真正实现

```
public class MessageAggregator<T> : Singleton<MessageAggregator<T>> {

    private readonly Dictionary<string, Action<object, MessageArgs<T>>> messages =
        new Dictionary<string, Action<object, MessageArgs<T>>>();

    public void Subscribe(string name, Action<object, MessageArgs<T>> handler) {
        if (!messages.ContainsKey(name))
            messages.Add(name, handler);
        else
            messages[name] += handler;
    }
    public void Publish(string name, object sender, MessageArgs<T> args) {
        if (messages.ContainsKey(name) && messages[name] != null)
            messages[name](sender, args);
    }
}
```

## 6.3 Module: 这里是模块级别的定义；在模块层面级别上；在 ViewModel 层面级别上等不面层面上的跨域适配定义与实现

- 不能像最开始一样把这里误当作 Model；这是一个 framework, 数据是定义在各个不同的具体应用里

### 6.3.1 ModuleBase.cs

```
public abstract class ModuleBase {
    public abstract void OnInitialize();
    public abstract void Excute();
}
```

### 6.3.2 ModuleBaseAdapter : CrossBindingAdaptor: 在模块层面上自定义实现了：模块层面级别的跨域跨程序集适配器

public class ModuleBaseAdapter : CrossBindingAdaptor { // 继承了 CrossBindingAdaptor 抽象基类

// 抽象基类里的三个抽象方法：需要实现

```
public override Type BaseCLRType { // 继承了 CrossBindingAdaptor 抽象基类，就应该需要覆写里面定义过的相关方法，改造成自己需要
    get {
        return typeof(ModuleBase);
    }
}
public override Type AdaptorType {
    get {
        return typeof(ModuleBaseAdapter);
    }
}
public override object CreateCLRInstance(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
    return new ModuleBaseAdapter(appdomain, instance);
}
```

// ModuleBase: Framework.MVVM 里定义的基础类；CrossBindingAdaptorType 是 ILRuntime.Runtime.Environment 里定义的公共接口类 in

```

class ModuleBaseAdaptor : ModuleBase, CrossBindingAdaptorType { // 好久没有写 cs 代码了，这里看得昏昏乎乎，类里定义类，还是
    ILTypeInstance instance;
    ILRuntime.Runtime.Environment.AppDomain appdomain;

// 实现对 ModuleBase 里的两个抽象方法的调控掌握
    IMethod _onInitialize;
    bool _onInitializeGot;
    IMethod _excute;
    bool _excuteGot;

    public ModuleBaseAdaptor() { }
    public ModuleBaseAdaptor(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
        this.appdomain = appdomain;
        this.instance = instance;
    }

    public ILTypeInstance ILInstance { get { return instance; } } // 返回类型的实体类

// 覆写 ModuleBase 里的两个抽象方法
    public override void OnInitialize() {
        if (!_onInitializeGot) {
            _onInitialize = instance.Type.GetMethod("OnInitialize");
            _onInitializeGot = true;
        }
        if (_onInitialize != null) {
            appdomain.Invoke(_onInitialize, instance, null);
        }
    }
    public override void Excute() {
        if (!_excuteGot) {
            _excute = instance.Type.GetMethod("Excute");
            _excuteGot = true;
        }
        if (_excute != null) {
            appdomain.Invoke(_excute, instance, null);
        }
    }
}
}

```

## 6.4 View

### 6.4.1 IView<ViewModelBase>

```

public interface IView<ViewModelBase> {
    ViewModelBase BindingContext {
        get;
        set;
    }
    void Reveal(bool immediate = false, Action action = null);
    void Hide(bool immediate = false, Action action = null);
}

```

### 6.4.2 UnityGuiView: IView<ViewModelBase>, 实现或是覆写基类以及泛型里的各种定义过的方法

```

// 继承自抽象基类：便需要实现公用接口类里面所定义的三个接口方法
// 泛型类型是 ViewModelBase，便可以实现或是覆写里面定义的各种公用、抽象或是 protected 方法
public abstract class UnityGuiView : IView<ViewModelBase> { // 仍然是抽象基类：这个类比较重要，明天早上再看一下

    private bool _isInitialized; // ViewModelBase 里同共有的

// 自己再定义的两个方法，供实现
    public virtual bool DestoryOnHide {
        get {
            return false;
        }
    }
    public virtual bool IsRoot {
        get {
            return false;
        }
    }
}

```





```

        if (HiddenAction != null)
            HiddenAction();
    }
    public virtual void OnDisappear() {
        GameObject.SetActive(false);
        BindingContext.OnFinishHide();
        if (DestroyOnHide)
            UnityEngine.Object.Destroy(GameObject);
    }
// OnInitialize() + OnDestroy(): ViewModelBase 里定义的抽象方法实现，实现必要的基类逻辑
    public virtual void OnDestroy() {
        if (BindingContext.IsRevealed)
            Hide(true);
        BindingContext.OnDestroy();
        BindingContext = null;
        viewModelProperty.OnValueChanged = null;
    }

// 对于视图中需要使用动画的情况：作出了考虑，定义了可以调用的方法
    protected virtual void StartAnimatedReveal() {
        CanvasGroup.interactable = false;
        Transform.localScale = Vector3.one;
        //huandong
        //CanvasGroup.DOFade(1, 0.2f).SetDelay(0.2f).OnComplete(() =>
        //{
        //    canvasGroup.interactable = true;
        //});
    }
    protected virtual void StartAnimatedHide() {
        CanvasGroup.interactable = false;
        //canvasGroup.DOFade(0, 0.2f).SetDelay(0.2f).OnComplete(() =>
        //{
        //    transform.localScale = Vector3.zero;
        //    canvasGroup.interactable = true;
        //});
    }

// 当有用户行为等导致视图变更的时候，需要调用的对所绑定的 ViewModel 的变更
    protected virtual void OnBindingContextChanged(ViewModelBase oldValue, ViewModelBase newValue) {
        binder.UnBind(oldValue);
        binder.Bind(newValue);
    }

// 主要是针对热更新 AB(AssetBundle) 包的处理的相关函数的定义
    public virtual string BundleName {
        get {
            return string.Empty;
        }
    }
    public virtual string AssetName {
        get {
            return string.Empty;
        }
    }
    public virtual string ViewName {
        get {
            return string.Empty;
        }
    }
    public virtual string ViewModelTypeName {
        get {
            return string.Empty;
        }
    }
    public GameObject GameObject {
        get;
        set;
    }
    private Transform _transform;
    public Transform Transform {
        get {
            if (_transform == null) {
                _transform = GameObject.transform;
            }
            return _transform;
        }
    }
    private CanvasGroup _canvasGroup;
    public CanvasGroup CanvasGroup {

```

```

        get {
            if (_canvasGroup == null)
                _canvasGroup = GameObject.GetComponent<CanvasGroup>();
            return _canvasGroup;
        }
    }
}

```

### 6.4.3 UnityGuiViewAdapter : CrossBindingAdaptor: 最鼻祖的实体基类

**public class UnityGuiViewAdapter** : CrossBindingAdaptor { // 最鼻祖的实体基类

// 这里是 *ModuleBaseAdapter* 里提供的三个接口方法: 这里想一想, 为什么要实现 *ModuleBaseAdapter* 里所定义的三个方法呢, 为什么需要?

```

    public override Type BaseCLRType {
        get {
            return typeof(UnityGuiView);
        }
    }
    public override Type AdaptorType {
        get {
            return typeof(UnityGuiViewAdapter);
        }
    }
    public override object CreateCLRInstance(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
        return new UnityGuiViewAdapter(appdomain, instance);
    }

```

```

class UnityGuiViewAdapter : UnityGuiView, CrossBindingAdaptorType { // ILRuntime.Environment.CrossBindingAdaptorType
    ILTypeInstance instance;
    ILRuntime.Runtime.Environment.AppDomain appdomain;
    object[] param2 = new object[2];

    public UnityGuiViewAdapter() { }
    public UnityGuiViewAdapter(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
        this.appdomain = appdomain;
        this.instance = instance;
    }
    public ILTypeInstance ILInstance {
        get { return instance; }
    }
}

```

// *UnityGuiView* 里所定义的所有公用方法的基类实现: 因为后来的继承类可以覆写, 但是也可以要求就请按照基类的实现去执行

**protected override void OnInitialize()** { // 辅助帮助抽象方法, 可以随每个视图里的不同需求再具体定义

```

    if (!_onInitializeGot) {
        _onInitialize = instance.Type.GetMethod("OnInitialize");
        _onInitializeGot = true;
    }
    if (_onInitialize != null && !isOnInitializeInvoking) {
        isOnInitializeInvoking = true;
        appdomain.Invoke(_onInitialize, instance);
        isOnInitializeInvoking = false;
    } else {
        base.OnInitialize();
    }
}
    public override void OnAppear() {
        if (!_onAppearGot) {
            _onAppear = instance.Type.GetMethod("OnAppear");
            _onAppearGot = true;
        }
        if (_onAppear != null && !isOnAppearInvoking) {
            isOnAppearInvoking = true;
            appdomain.Invoke(_onAppear, instance);
            isOnAppearInvoking = false;
        } else {
            base.OnAppear();
        }
    }
}
    public override void OnRevealed() {
        if (!_onRevealedGot) {
            _onRevealed = instance.Type.GetMethod("OnRevealed");
            _onRevealedGot = true;
        }
        if (_onRevealed != null && !isOnRevealedInvoking) {
            isOnRevealedInvoking = true;
            appdomain.Invoke(_onRevealed, instance);
            isOnRevealedInvoking = false;
        } else {

```

```

        base.OnRevealed();
    }
}
public override void OnHidden() {
    if (!_onHiddenGot) {
        _onHidden = instance.Type.GetMethod("OnHidden");
        _onHiddenGot = true;
    }
    if (_onHidden != null && !isOnHiddenInvoking) {
        isOnHiddenInvoking = true;
        appdomain.Invoke(_onHidden, instance);
        isOnHiddenInvoking = false;
    } else {
        base.OnHidden();
    }
}
public override void OnDisappear() {
    if (!_onDisappearGot) {
        _onDisappear = instance.Type.GetMethod("OnDisappear");
        _onDisappearGot = true;
    }
    if (_onDisappear != null && !isOnDisappearInvoking) {
        isOnDisappearInvoking = true;
        appdomain.Invoke(_onDisappear, instance);
        isOnDisappearInvoking = false;
    } else {
        base.OnDisappear();
    }
}
public override void OnDestroy() {
    if (!_onDestroyGot) {
        _onDestroy = instance.Type.GetMethod("OnDestroy");
        _onDestroyGot = true;
    }
    if (_onDestroy != null && !isOnDestroyInvoking) {
        isOnDestroyInvoking = true;
        appdomain.Invoke(_onDestroy, instance);
        isOnDestroyInvoking = false;
    } else {
        base.OnDestroy();
    }
}
protected override void StartAnimatedReveal() {
    if (!_startAnimatedRevealGot) {
        _startAnimatedReveal = instance.Type.GetMethod("StartAnimatedReveal");
        _startAnimatedRevealGot = true;
    }
    if (_startAnimatedReveal != null && !isStartAnimatedRevealInvoking) {
        isStartAnimatedRevealInvoking = true;
        appdomain.Invoke(_startAnimatedReveal, instance);
        isStartAnimatedRevealInvoking = false;
    } else {
        base.StartAnimatedReveal();
    }
}
protected override void StartAnimatedHide() {
    if (!_startAnimatedHideGot) {
        _startAnimatedHide = instance.Type.GetMethod("StartAnimatedHide");
        _startAnimatedHideGot = true;
    }
    if (_startAnimatedHide != null && !isStartAnimatedHideInvoking) {
        isStartAnimatedHideInvoking = true;
        appdomain.Invoke(_startAnimatedHide, instance);
        isStartAnimatedHideInvoking = false;
    } else {
        base.StartAnimatedHide();
    }
}
protected override void OnBindingContextChanged(ViewModelBase oldValue, ViewModelBase newValue) {
    if (!_onBindingContextChangedGot) {
        _onBindingContextChanged = instance.Type.GetMethod("OnBindingContextChanged");
        _onBindingContextChangedGot = true;
    }
    if (_onBindingContextChanged != null && !isOnBindingContextChangedInvoking) {
        isOnBindingContextChangedInvoking = true;
        appdomain.Invoke(_onBindingContextChanged, instance, param2);
        isOnBindingContextChangedInvoking = false;
    } else {
        base.OnBindingContextChanged(oldValue, newValue);
    }
}

```

```

    }
}

// 下面是处理热更新 AB 包相关的回调接口控制公用方法：定义为基类实现，因为此类为第一个实体的基类
public override string BundleName {
    get {
        if (!_getBundleNameGot) {
            _getBundleName = instance.Type.GetMethod("get_BundleName", 0);
            _getBundleNameGot = true;
        }
        if (_getBundleName != null && !isGetBundleNameInvoking) {
            isGetBundleNameInvoking = true;
            var res = (string)appdomain.Invoke(_getBundleName, instance, null);
            isGetBundleNameInvoking = false;
            return res;
        } else {
            return base.BundleName;
        }
    }
}

public override string AssetName {
    get {
        if (!_getAssetNameGot) {
            _getAssetName = instance.Type.GetMethod("get_AssetName", 0);
            _getAssetNameGot = true;
        }
        if (_getAssetName != null && !isGetAssetNameInvoking) {
            isGetAssetNameInvoking = true;
            var res = (string)appdomain.Invoke(_getAssetName, instance, null);
            isGetAssetNameInvoking = false;
            return res;
        } else {
            return base.AssetName;
        }
    }
}

public override string ViewName {
    get {
        if (!_getViewNameGot) {
            _getViewName = instance.Type.GetMethod("get_ViewName", 0);
            _getViewNameGot = true;
        }
        if (_getViewName != null && !isGetViewNameInvoking) {
            isGetViewNameInvoking = true;
            var res = (string)appdomain.Invoke(_getViewName, instance, null);
            isGetViewNameInvoking = false;
            return res;
        } else {
            return base.ViewName;
        }
    }
}

public override string ViewModelTypeName {
    get {
        if (!_getViewModelTypeNameGot) {
            _getViewModelTypeName = instance.Type.GetMethod("get_ViewModelTypeName", 0);
            _getViewModelTypeNameGot = true;
        }
        if (_getViewModelTypeName != null && !isGetViewModelTypeNameInvoking) {
            isGetViewModelTypeNameInvoking = true;
            var res = (string)appdomain.Invoke(_getViewModelTypeName, instance, null);
            isGetViewModelTypeNameInvoking = false;
            return res;
        } else {
            return base.ViewModelTypeName;
        }
    }
}

// 覆写 UnityGuiView 里定义的两个公用抽象方法
public override bool DestoryOnHide {
    get {
        if (!_getDestoryOnHideGot) {
            _getDestoryOnHide = instance.Type.GetMethod("get_DestoryOnHide", 0);
            _getDestoryOnHideGot = true;
        }
        if (_getDestoryOnHide != null && !isGetDestoryOnHideInvoking) {
            isGetDestoryOnHideInvoking = true;
            var res = (bool)appdomain.Invoke(_getDestoryOnHide, instance, null);

```

```

        isGetDestoryOnHideInvoking = false;
        return res;
    } else {
        return base.DestoryOnHide;
    }
}
}
}
public override bool IsRoot {
    get {
        if (!_getIsRootGot) {
            isGetIsRootInvoking = true;
            _getIsRootGot = true;
        }
        if (_getIsRoot != null && !isGetIsRootInvoking) {
            isGetIsRootInvoking = true;
            var res = (bool)appdomain.Invoke(_getIsRoot, instance, null);
            isGetIsRootInvoking = false;
            return res;
        } else {
            return base.IsRoot;
        }
    }
}
}
}

// 每个标记变量对应的三小变量
IMethod _onInitialize;
bool _onInitializeGot;
bool isOnInitializeInvoking = false;

IMethod _onAppear;
bool _onAppearGot;
bool isOnAppearInvoking = false;
IMethod _onRevealed;
bool _onRevealedGot;
bool isOnRevealedInvoking = false;
IMethod _onHidden;
bool _onHiddenGot;
bool isOnHiddenInvoking = false;
IMethod _onDisappear;
bool _onDisappearGot;
bool isOnDisappearInvoking = false;
IMethod _onDestory;
bool _onDestoryGot;
bool isOnDestoryInvoking = false;
IMethod _startAnimatedReveal;
bool _startAnimatedRevealGot;
bool isStartAnimatedRevealInvoking = false;
IMethod _startAnimatedHide;
bool _startAnimatedHideGot;
bool isStartAnimatedHideInvoking = false;
IMethod _getBundleName;
bool _getBundleNameGot;
bool isGetBundleNameInvoking = false;
IMethod _getAssetName;
bool _getAssetNameGot;
bool isGetAssetNameInvoking = false;
IMethod _getViewName;
bool _getViewNameGot;
bool isGetViewNameInvoking = false;
IMethod _getDestoryOnHide;
bool _getDestoryOnHideGot;
bool isGetDestoryOnHideInvoking = false;
IMethod _getIsRoot;
bool _getIsRootGot;
bool isGetIsRootInvoking = false;
IMethod _getViewModelTypeName;
bool _getViewModelTypeNameGot;
bool isGetViewModelTypeNameInvoking = false;
IMethod _onBindingContextChanged;
bool _onBindingContextChangedGot;
bool isOnBindingContextChangedInvoking = false;
}

```

## 6.5 ViewModel

### 6.5.1 ViewModelBase.cs

```
public class ViewModelBase {
    private bool _isInitialize;
    public bool IsRevealInProgress {
        get;
        private set;
    }
    public bool IsRevealed {
        get;
        private set;
    }
    public bool IsHideInProgress {
        get;
        private set;
    }
    public ViewModelBase ParentViewModel {
        get;
        set;
    }
    public virtual void OnStartReveal() {
        IsRevealInProgress = true;
        if (!_isInitialize) {
            OnInitialize();
            _isInitialize = true;
        }
    }
    public virtual void OnFinishReveal() {
        IsRevealInProgress = false;
        IsRevealed = true;
    }
    public virtual void OnStartHide() {
        IsHideInProgress = true;
    }
    public virtual void OnFinishHide() {
        IsHideInProgress = false;
        IsRevealed = false;
    }
}

public virtual void OnDestroy() {}
protected virtual void OnInitialize() {}
}
```

### 6.5.2 ViewModelBaseAdapter : CrossBindingAdapter: 自定义实现了 ViewModel 的跨域跨程序集适配

```
// 作为两个不同程序集中的 ViewModel 的桥梁适配器:
```

```
public class ViewModelBaseAdapter : CrossBindingAdaptor { // 这里需要再想一想：为什么外面大类，里面小类，继承的基类不一样，公用与
```

```
// 实现了基类 CrossBindingAdapter 里的其中三个抽象方法
```

```
public override Type BaseCLRType {
    get {
        return typeof(ViewModelBase);
    }
}

public override Type AdaptorType {
    get {
        return typeof(ViewModelBaseAdaptor);
    }
}
```

```
public override object CreateCLRInstance(ILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
    return new ViewModelBaseAdaptor(appdomain, instance);
}
```

```
// 作为两个不同程序集中的 ViewModel 的桥梁适配器：继承自 ViewModelBase，需要实现里而定义过的甩有 6 个抽象方法
```

```
class ViewModelBaseAdapter : ViewModelBase, CrossBindingAdapterType { // <<<<<<<<<<<<<<<<
    ILTypeInstance instance; // 来自于 CrossBindingAdapterType ?
    IILRuntime.Runtime.Environment.AppDomain appdomain;

    public ViewModelBaseAdapter() { }
    public ViewModelBaseAdapter(IILRuntime.Runtime.Environment.AppDomain appdomain, ILTypeInstance instance) {
        this.appdomain = appdomain;
        this.instance = instance;
    }
}
```



// 来自于 *CrossBindingAdapterType* 接口的实体实现

```
public ILTypeInstance ILInstance { get { return instance; } }
```

// 作为两个不同程序集中的 *ViewModel* 的桥梁适配器：继承自 *ViewModelBase*，需要实现里而定义过的甩有 6 个抽象方法

```
public override void OnStartReveal() {  
    if (!_onStartRevealGot) {  
        _onStartReveal = instance.Type.GetMethod("OnStartReveal");  
        _onStartRevealGot = true;  
    }  
    if (_onStartReveal != null && !_isOnStartRevealInvoking) {  
        _isOnStartRevealInvoking = true;  
        appdomain.Invoke(_onStartReveal, instance);  
        _isOnStartRevealInvoking = false;  
    } else  
        base.OnStartReveal();  
}  
public override void OnFinishReveal() {  
    if (!_onFinishRevealGot) {  
        _onFinishReveal = instance.Type.GetMethod("OnFinishReveal");  
        _onFinishRevealGot = true;  
    }  
    if (_onFinishReveal != null && !_isOnFinishRevealInvoking) {  
        _isOnFinishRevealInvoking = true;  
        appdomain.Invoke(_onFinishReveal, instance);  
        _isOnFinishRevealInvoking = false;  
    } else  
        base.OnFinishReveal();  
}  
public override void OnStartHide() {  
    if (!_onStartHideGot) {  
        _onStartHide = instance.Type.GetMethod("OnStartHide");  
        _onStartHideGot = true;  
    }  
    if (_onStartHide != null && !_isOnStartHideInvoking) {  
        _isOnStartHideInvoking = true;  
        appdomain.Invoke(_onStartHide, instance);  
        _isOnStartHideInvoking = false;  
    } else  
        base.OnStartHide();  
}  
public override void OnFinishHide() {  
    if (!_onFinishHideGot) {  
        _onFinishHide = instance.Type.GetMethod("OnFinishHide");  
        _onFinishHideGot = true;  
    }  
    if (_onFinishHide != null && !_isOnFinishHideInvoking) {  
        _isOnFinishHideInvoking = true;  
        appdomain.Invoke(_onFinishHide, instance);  
        _isOnFinishHideInvoking = false;  
    } else  
        base.OnFinishHide();  
}  
public override void OnDestroy() {  
    if (!_onDestoryGot) {  
        _onDestory = instance.Type.GetMethod("OnDestory");  
        _onDestoryGot = true;  
    }  
    if (_onDestory != null && !_isOnDestoryInvoking) {  
        _isOnDestoryInvoking = true;  
        appdomain.Invoke(_onDestory, instance);  
        _isOnDestoryInvoking = false;  
    } else  
        base.OnDestory();  
}  
protected override void OnInitialize() {  
    if (!_onInitializeGot) {  
        _onInitialize = instance.Type.GetMethod("OnInitialize");  
        _onInitializeGot = true;  
    }  
    if (_onInitialize != null && !_isOnInitializeInvoking) {  
        _isOnInitializeInvoking = true;  
        appdomain.Invoke(_onInitialize, instance);  
        _isOnInitializeInvoking = false;  
    } else  
        base.OnInitialize();  
}  
// _onStart/_onFinish: Reveal + Hide;  
IMethod _onStartReveal;  
bool _onStartRevealGot;
```

```

        bool _isOnStartRevealInvoking = false;
        IMethod _onFinishReveal;
        bool _onFinishRevealGot;
        bool _isOnFinishRevealInvoking = false;
        IMethod _onStartHide;
        bool _onStartHideGot;
        bool _isOnStartHideInvoking = false;
        IMethod _onFinishHide;
        bool _onFinishHideGot;
        bool _isOnFinishHideInvoking = false;
    // _onInitialize + _onDestroy
    IMethod _onInitialize;
    bool _onInitializeGot;
    bool _isOnInitializeInvoking = false;
    IMethod _onDestroy;
    bool _onDestroyGot;
    bool _isOnDestroyInvoking = false;
}
}
}

```

## 7 Framework.Util 各种帮助类

### 7.1 Singleton<T> + SingletonMono<T> : MonoBehaviour

```

public class Singleton<T> where T : class, new() {
    protected static T _instance;
    public static T Instance {
        get {
            if (_instance == null)
                _instance = new T();
            return _instance;
        }
    }
    public static T GetInstance() {
        return Instance;
    }
}

public class SingletonMono<T> : MonoBehaviour where T : MonoBehaviour { // MonoBehaviour 类型的泛型基类
    protected static T _instance;
    public static T Instance {
        get {
            // 实例化一个游戏控件 (GameObject), 再将泛型类型以元素的形式挂上去, 更新控件的名字
            // 是因为控件具备生命周期, 所以实例就是 MonoBehaviour 的继承类了吗? 好像是这样
            if (_instance == null) {
                GameObject obj = new GameObject();
                _instance = obj.AddComponent<T>();
                obj.name = _instance.GetType().Name;
            }
            return _instance; // 返回实例
        }
    }
    public static T GetInstance() {
        return Instance;
    }
    public static void DestroyInstance() {
        if (_instance == null)
            return;
        GameObject obj = _instance.gameObject;
        // 想一下: 下面这一行, 这里为什么会被亚掉? 应该是正常运行这行才对呀, 还是说控件池相关呢
        // ResourceMgr.Instance.DestroyObject(obj);
    }
}

```

### 7.2 static class JsonSerializer: 静态帮助类, 帮助将网络下载的资源包解析为相应的封装类型

```

public static class JsonSerializer {
    public static JsonValue Deserialize(string jsonString) {
        try {
            if (string.IsNullOrEmpty(jsonString))
                return new JsonObject();
            var re = JsonValue.Parse(jsonString);

```

```

        return re;
    } catch (Exception ex) {
        DebugHelper.LogError(string.Format("{0}{1}", jsonString, ex), true);
        return null;
    }
}
}
}

```

## 8 HotFix 中使用 MVVM 架构实现热更新的搭配与相关的链接 ()

## 9 Control: 当写 Control 的时候感觉好像是 MVC, 但实际上仍然是 MVVM, 后面会有热更新视图模块

### 9.1 Resource: 热更新里的资源处理桥接 (这里需要再理解消化得透彻一点儿)

#### 9.1.1 abstract class ResourceHandleBase: 服务器热更新资源包程序包处理: 抽象基类

- 看见没有: Unity 的正常程序集里有一套, 热更新程序集里也有一套; 两套不同的程序集跨域交互需要使用各个不同层面的适配器来适配相认, 但是某些必要的逻辑即便两套程序集都用到, 却没有办法再抽象提供或是封装? 再想想吧, 这套游戏框架还是狠值得自己深入学习的!

```

// 服务器热更新资源包程序包处理: 抽象基类
public abstract class ResourceHandleBase {

    // 同步加载
    #region Load
    public abstract T LoadAsset<T>(string bundleName, string assetName,
                                     EAssetBundleUnloadLevel unloadLevel =
                                     EAssetBundleUnloadLevel.ChangeSceneOver) where T : UnityEngine.Object;

    public abstract TMP_FontAsset LoadTMP_FontAsset(string bundleName, string assetName,
                                                      EAssetBundleUnloadLevel unloadLevel =
                                                      EAssetBundleUnloadLevel.ChangeSceneOver);

    public abstract Font LoadFont(string bundleName, string assetName,
                                    EAssetBundleUnloadLevel unloadLevel =
                                    EAssetBundleUnloadLevel.ChangeSceneOver);

    public abstract AnimationClip LoadAnimationClip(string bundleName, string assetName,
                                                      EAssetBundleUnloadLevel unloadLevel =
                                                      EAssetBundleUnloadLevel.ChangeSceneOver);

    public abstract AnimatorOverrideController LoadAnimatorOverrideController(string bundleName, string assetName,
                                                                                  EAssetBundleUnloadLevel unloadLevel =
                                                                                  EAssetBundleUnloadLevel.ChangeSceneOver);

    public abstract RuntimeAnimatorController LoadRuntimeAnimatorController(string bundleName, string assetName,
                                                                                EAssetBundleUnloadLevel unloadLevel =
                                                                                EAssetBundleUnloadLevel.ChangeSceneOver);

    public abstract AudioClip LoadAudioClip(string bundleName, string assetName,
                                              EAssetBundleUnloadLevel unloadLevel =
                                              EAssetBundleUnloadLevel.ChangeSceneOver);

    public abstract Material LoadMaterial(string bundleName, string assetName,
                                           EAssetBundleUnloadLevel unloadLevel =
                                           EAssetBundleUnloadLevel.ChangeSceneOver);

    public abstract TextAsset LoadTextAsset(string bundleName, string assetName,
                                              EAssetBundleUnloadLevel unloadLevel =
                                              EAssetBundleUnloadLevel.ChangeSceneOver);

    public abstract Sprite LoadSprite(string bundleName, string assetName,
                                        EAssetBundleUnloadLevel unloadLevel =
                                        EAssetBundleUnloadLevel.ChangeSceneOver);

    public abstract Texture2D LoadTexture2D(string bundleName, string assetName,
                                              EAssetBundleUnloadLevel unloadLevel =
                                              EAssetBundleUnloadLevel.ChangeSceneOver);

    public abstract void LoadScene(string bundleName, string assetName,
                                    EAssetBundleUnloadLevel unloadLevel =
                                    EAssetBundleUnloadLevel.ChangeSceneOver, bool isAdditive = false);

    public abstract GameObject LoadClone(string bundleName, string assetName,
                                           EAssetBundleUnloadLevel unloadLevel =
                                           EAssetBundleUnloadLevel.ChangeSceneOver);

    #endregion

    // 异步加载
    #region LoadAsync
    public abstract void LoadAssetAsync<T>(string bundleName, string assetName, Action<T> onSuccess,
                                             EAssetBundleUnloadLevel unloadLevel =

```

```

        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadTMP_FontAssetAsync(string bundleName, string assetName, Action<TMP_FontAsset> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadFontAsync(string bundleName, string assetName, Action<Font> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadAnimationClipAsync(string bundleName, string assetName, Action<AnimationClip> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadAnimatorOverrideControllerAsync(string bundleName, string assetName, Action<AnimatorOverrideController> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadRuntimeAnimatorControllerAsync(string bundleName, string assetName, Action<RuntimeAnimatorController> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadAudioClipAsync(string bundleName, string assetName, Action<AudioClip> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadMaterialAsync(string bundleName, string assetName, Action<Material> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadTextAssetAsync(string bundleName, string assetName, Action<TextAsset> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadSpriteAsync(string bundleName, string assetName, Action<Sprite> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadTexture2DAsync(string bundleName, string assetName, Action<Texture2D> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);
public abstract void LoadSceneAsync(string bundleName, string assetName, Action onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isAdditive = false);
public abstract void LoadCloneAsync(string bundleName, string assetName, Action<GameObject> onSuccess,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false);

#endregion
#region Unload
    public abstract void Unload(string keyName, bool allObjects);
    public abstract void UnloadAll();
#endregion
    public abstract void LoadTexture2DAsync(string name, Action<Texture2D> onSuccess, Action onFail, bool needCache);
}

```

## 9.1.2 ResourceHelper

// 资源加载接口类：什么叫桥接？

```

public class ResourceHelper {
    static ResourceHandleBase _handle;
    static ResourceHandleBase Handle {
        get {
            if (_handle == null) {
                _handle = new ResourceMapHandle();
            }
            return _handle;
        }
    }
#region Load
    public static T LoadAsset<T>(string bundleName, string assetName,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver) where T : UnityEngine.Object {
        return Handle.LoadAsset<T>(bundleName, assetName, unloadLevel);
    }
    public static TMP_FontAsset LoadTMP_FontAsset(string bundleName, string assetName,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver) {
        return Handle.LoadTMP_FontAsset(bundleName, assetName, unloadLevel);
    }
    public static Font LoadFont(string bundleName, string assetName,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver) {
        return Handle.LoadFont(bundleName, assetName, unloadLevel);
    }
    public static AnimationClip LoadAnimationClip(string bundleName, string assetName,
        EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver) {

```

```

        return Handle.LoadAnimationClip(bundleName, assetName, unloadLevel);
    }
    public static AnimatorOverrideController LoadAnimatorOverrideController(string bundleName, string assetName,
                                                                              EAssetBundleUnloadLevel unloadLevel =
                                                                              EAssetBundleUnloadLevel.ChangeSceneOver) {
        return Handle.LoadAnimatorOverrideController(bundleName, assetName, unloadLevel);
    }
    public static RuntimeAnimatorController LoadRuntimeAnimatorController(string bundleName, string assetName,
                                                                              EAssetBundleUnloadLevel unloadLevel =
                                                                              EAssetBundleUnloadLevel.ChangeSceneOver) {
        return Handle.LoadRuntimeAnimatorController(bundleName, assetName, unloadLevel);
    }
    public static AudioClip LoadAudioClip(string bundleName, string assetName,
                                             EAssetBundleUnloadLevel unloadLevel =
                                             EAssetBundleUnloadLevel.ChangeSceneOver) {
        return Handle.LoadAudioClip(bundleName, assetName, unloadLevel);
    }
    public static Material LoadMaterial(string bundleName, string assetName,
                                         EAssetBundleUnloadLevel unloadLevel =
                                         EAssetBundleUnloadLevel.ChangeSceneOver) {
        return Handle.LoadMaterial(bundleName, assetName, unloadLevel);
    }
    public static TextAsset LoadTextAsset(string bundleName, string assetName,
                                           EAssetBundleUnloadLevel unloadLevel =
                                           EAssetBundleUnloadLevel.ChangeSceneOver) {
        return Handle.LoadTextAsset(bundleName, assetName, unloadLevel);
    }
    public static Sprite LoadSprite(string bundleName, string assetName,
                                     EAssetBundleUnloadLevel unloadLevel =
                                     EAssetBundleUnloadLevel.ChangeSceneOver) {
        return Handle.LoadSprite(bundleName, assetName, unloadLevel);
    }
    public static Texture2D LoadTexture2D(string bundleName, string assetName,
                                           EAssetBundleUnloadLevel unloadLevel =
                                           EAssetBundleUnloadLevel.ChangeSceneOver) {
        return Handle.LoadTexture2D(bundleName, assetName, unloadLevel);
    }
    public static void LoadScene(string bundleName, string assetName,
                                  EAssetBundleUnloadLevel unloadLevel =
                                  EAssetBundleUnloadLevel.ChangeSceneOver, bool isAdditive = false) {
        Handle.LoadScene(bundleName, assetName, unloadLevel, isAdditive);
    }
    public static GameObject LoadClone(string bundleName, string assetName,
                                         EAssetBundleUnloadLevel unloadLevel =
                                         EAssetBundleUnloadLevel.ChangeSceneOver) {
        return Handle.LoadClone(bundleName, assetName, unloadLevel);
    }
}
#endregion
#region LoadAsyn
public static void LoadAssetAsyn<T>(string bundleName, string assetName, Action<T> onSuccess,
                                     EAssetBundleUnloadLevel unloadLevel =
                                     EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) where T : UnityEngine.Object {
    Handle.LoadAssetAsyn<T>(bundleName, assetName, onSuccess, unloadLevel);
}
public static void LoadTMP_FontAssetAsyn(string bundleName, string assetName, Action<TMP_FontAsset> onSuccess,
                                           EAssetBundleUnloadLevel unloadLevel =
                                           EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadTMP_FontAssetAsyn(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public static void LoadFontAsyn(string bundleName, string assetName, Action<Font> onSuccess,
                                  EAssetBundleUnloadLevel unloadLevel =
                                  EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadFontAsyn(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public static void LoadAnimationClipAsyn(string bundleName, string assetName, Action<AnimationClip> onSuccess,
                                           EAssetBundleUnloadLevel unloadLevel =
                                           EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadAnimationClipAsyn(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public static void LoadAnimatorOverrideControllerAsyn(string bundleName, string assetName, Action<AnimatorOverrideController> onSuccess,
                                                         EAssetBundleUnloadLevel unloadLevel =
                                                         EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadAnimatorOverrideControllerAsyn(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public static void LoadRuntimeAnimatorControllerAsyn(string bundleName, string assetName, Action<RuntimeAnimatorController> onSuccess,
                                                         EAssetBundleUnloadLevel unloadLevel =
                                                         EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadRuntimeAnimatorControllerAsyn(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
}

```

```

public static void LoadAudioClipAsync(string bundleName, string assetName, Action<AudioClip> onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadAudioClipAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public static void LoadMaterialAsync(string bundleName, string assetName, Action<Material> onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadMaterialAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public static void LoadTextAssetAsync(string bundleName, string assetName, Action<TextAsset> onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadTextAssetAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public static void LoadSpriteAsync(string bundleName, string assetName, Action<Sprite> onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadSpriteAsync(bundleName, assetName, onSuccess, unloadLevel);
}
public static void LoadTexture2DAsync(string bundleName, string assetName, Action<Texture2D> onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadTexture2DAsync(bundleName, assetName, onSuccess, unloadLevel);
}
public static void LoadSceneAsync(string bundleName, string assetName, Action onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isAdditive = false) {
    Handle.LoadSceneAsync(bundleName, assetName, onSuccess, unloadLevel, isAdditive);
}
public static void LoadCloneAsync(string bundleName, string assetName, Action<GameObject> onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Handle.LoadCloneAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
#endregion
#region Unload
#endregion
public static void LoadTexture2DAsync(string name, Action<Texture2D> onSuccess, Action onFail, bool needCache = true) {
    Handle.LoadTexture2DAsync(name, onSuccess, onFail, needCache);
}
}

```

### 9.1.3 ResourceMapHandle : ResourceHandleBase: 感觉这里两套程序集能够交接起来，这里需要好好想想理解清楚

```

public class ResourceMapHandle : ResourceHandleBase {
    IResourceLoader Loader {
        get {
            return ResourceConstant.Loader;
        }
    }
}
#region Load
public override T LoadAsset<T>(string bundleName, string assetName,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadAsset<T>(bundleName, assetName, unloadLevel);
}
public override TMP_FontAsset LoadTMP_FontAsset(string bundleName, string assetName,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadTMP_FontAsset(bundleName, assetName, unloadLevel);
}
public override Font LoadFont(string bundleName, string assetName,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadFont(bundleName, assetName, unloadLevel);
}
public override AnimationClip LoadAnimationClip(string bundleName, string assetName,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadAnimationClip(bundleName, assetName, unloadLevel);
}
public override AnimatorOverrideController LoadAnimatorOverrideController(string bundleName, string assetName,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadAnimatorOverrideController(bundleName, assetName, unloadLevel);
}
}

```

```

}
public override RuntimeAnimatorController LoadRuntimeAnimatorController(string bundleName, string assetName,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadRuntimeAnimatorController(bundleName, assetName, unloadLevel);
}
public override AudioClip LoadAudioClip(string bundleName, string assetName,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadAudioClip(bundleName, assetName, unloadLevel);
}
public override Material LoadMaterial(string bundleName, string assetName,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadMaterial(bundleName, assetName, unloadLevel);
}
public override TextAsset LoadTextAsset(string bundleName, string assetName,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadTextAsset(bundleName, assetName, unloadLevel);
}
public override Sprite LoadSprite(string bundleName, string assetName,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadSprite(bundleName, assetName, unloadLevel);
}
public override Texture2D LoadTexture2D(string bundleName, string assetName,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadTexture2D(bundleName, assetName, unloadLevel);
}
public override void LoadScene(string bundleName, string assetName,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver, bool isAdditive = false) {
    Loader.LoadScene(bundleName, assetName, unloadLevel);
}
public override GameObject LoadClone(string bundleName, string assetName,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver) {
    return Loader.LoadClone(bundleName, assetName, unloadLevel);
}
}
#endregion
#region LoadAsync
public override void LoadAssetAsync<T>(string bundleName, string assetName, Action<T> onSuccess,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadAssetAsync<T>(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadTMP_FontAssetAsync(string bundleName, string assetName, Action<TMP_FontAsset> onSuccess,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadTMP_FontAssetAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadFontAsync(string bundleName, string assetName, Action<Font> onSuccess,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadFontAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadAnimationClipAsync(string bundleName, string assetName, Action<AnimationClip> onSuccess,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadAnimationClipAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadAnimatorOverrideControllerAsync(string bundleName, string assetName, Action<AnimatorOverrideController> onSuccess,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadAnimatorOverrideControllerAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadRuntimeAnimatorControllerAsync(string bundleName, string assetName, Action<RuntimeAnimatorController> onSuccess,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadRuntimeAnimatorControllerAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadAudioClipAsync(string bundleName, string assetName, Action<AudioClip> onSuccess,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadAudioClipAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadMaterialAsync(string bundleName, string assetName, Action<Material> onSuccess,
                                                                    EAssetBundleUnloadLevel unloadLevel =
                                                                    EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadMaterialAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
}

```



```

        EAssetBundleUnloadLevel unloadLevel =
            EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadMaterialAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadTextAssetAsync(string bundleName, string assetName, Action<TextAsset> onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadTextAssetAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadSpriteAsync(string bundleName, string assetName, Action<Sprite> onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadSpriteAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadTexture2DAsync(string bundleName, string assetName, Action<Texture2D> onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadTexture2DAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
public override void LoadSceneAsync(string bundleName, string assetName, Action onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isAdditive = false) {
    Loader.LoadSceneAsync(bundleName, assetName, onSuccess, unloadLevel, isAdditive);
}
public override void LoadCloneAsync(string bundleName, string assetName, Action<GameObject> onSuccess,
    EAssetBundleUnloadLevel unloadLevel =
        EAssetBundleUnloadLevel.ChangeSceneOver, bool isForceInterruptLoad = false) {
    Loader.LoadCloneAsync(bundleName, assetName, onSuccess, unloadLevel, isForceInterruptLoad);
}
}
#endregion
#region Unload
public override void Unload(string keyName, bool allObjects) {
    Loader.Unload(keyName, allObjects);
}
public override void UnloadAll() {
    Loader.UnloadAll();
}
}
#endregion
public override void LoadTexture2DAsync(string name, Action<Texture2D> onSuccess, Action onFail, bool needCache) {
    Loader.LoadTexture2DAsync(name, onSuccess, onFail, needCache);
}
}
}

```

## 9.2 Scene: 场景热更新反序列化为 unity 游戏引擎所能识别和可执行场景控件程序等

- 回想一下热更新的过程：从网络服务器上下载出需要的资源包或是程序包，它是序列化后的数据；要把它还原成 unity 认得认识的场景等，还需要一个反序列化的过程
- 那么这个包裹里，就专职负责：如何从下载的资源包里游戏引擎场景相关的序列化数据还原为 unity 游戏引擎中认识并且可执行的游戏引擎程序集里的场景控件等，这个过程，所有场景相关的
- 那么这里可以封装和包含的几个类就包括了：如果可以封装成为的（抽象）基类；根据各个不同应用实际需要而可以实例化成了几个不同的场景类型的反序列化定义类；如果可以，如果有好几个不同的场景，如有必要，还可以有一个必要的管理多个不同场景的场景管理者类

### 9.2.1 abstract class SceneBase: 热更新场景抽象基类

```

// 热更新场景基类:
public abstract class SceneBase {
    public SceneData Data {
        get;
        set;
    }
    public SceneTypeData TypeData {
        get;
        set;
    }
    public GameObject GameObject {
        get;
    }
}

```

```

        set;
    }
    // 家具的集合
    public Dictionary<int, FurnitureBase> furnitures = new Dictionary<int, FurnitureBase>();
    public SceneBase(int type) {
        Data = new SceneData();
        Data.type = type;
        Data.materialDatas = new Dictionary<string, MaterialData>();
        Data.furnitureDatas = new Dictionary<int, FurnitureData>();
        TypeData = TypeDataManager.GetSceneTypeData(Data.type);
    }
    public SceneBase(SceneData data) {
        Data = data;
        TypeData = TypeDataManager.GetSceneTypeData(Data.type);
    }
    public void LoadSceneGameObject() {
        ResourceConstant.Loader.LoadCloneAsync(TypeData.bundleName, TypeData.assetName, (go) => {
            GameObject = go;
            SetGameObjectName();
            SceneManager.Instance.CurrentScene = this;
            Initialize();
        }, EAssetBundleUnLoadLevel.ChangeSceneOver);
    }
    protected abstract void SetGameObjectName();
    protected abstract void Initialize();
    public virtual void Dispose() {
        ResourceConstant.Loader.Unload(TypeData.bundleName, true);
    }
}

```

## 9.2.2 程序中热更新用到三种不同场景，这里给个样例，最简单最特殊的 ShowScene

```

// 空间秀场景：吃货天空的鬼窝秀
public class ShowScene : SceneBase {
    // 这些这里可以有 unity 认得的至少一部分控件（因为热更新程序持有 UnityEngine.dll 的程序集引用？想一想）
    public Transform OneGameObjectRoot { // Transform Transform ..... 某个游戏控件的位置信息
        get;
        set;
    }
    public ShowScene(int type) : base(type) {}
    public ShowScene(SceneData data) : base(data) {}

    protected override void SetGameObjectName() {
        GameObject.name = "Show_" + TypeData.id;
    }
    protected override void Initialize() {
        OneGameObjectRoot = GameObject.FindChildByName("OneGameObjectRoot").transform;
        InitializeTypetwos();
    }
    void InitializeTypetwos() { // 初始化某种类型 Typetwo 类型的元件（控件或集）
        foreach (var typetwoData in Data.typetwoDatas.Values) {
            TypetwoTypeData typetwoTypeData = TypeDataManager.GetTypetwoTypeData(typetwoData.type);
            TypetwoBase typetwoBase;
            // 再然后，可以根据 Typetwo 类型是单个数据还是集合类再作进一步的初始化到最小元件单位（？就是层层拆解，反序列化实例化成真）
            // 这里的部分逻辑略去
        }
    }
    public override void Dispose() {
        base.Dispose();
        foreach (var typetwo in typetwos.Values) {
            typetwo.Dispose();
        }
    }
}

```

## 9.2.3 SceneManager: 场景管理器, 对于有需要必要时需要进行热更新的场景的相关逻辑（加载，创建，渐近切换等）的封装定义管理

```

// 场景管理器：我的游戏里也写过好几个不同的管理类，热更新里的管理类与 unity 里的普通管理类有什么不同呢？
public class SceneManager { // unity 里不同场景的编号不同，这里以 int 值不同来区分不同的游戏场景

    private static SceneManager instance; // 希望是单例模式，不涉及多线程安全
    public static SceneManager Instance {
        get {
            if (instance == null)
                instance = new SceneManager();
        }
    }
}

```

```

        return instance;
    }
}

// 当前场景
public SceneBase CurrentScene {
    get;
    set;
}
public int currentSelectGameObjectInstanceID;

// 创建一个新场景：根据传进来的参数值，来轮询实例化对象的场景（这个包裹里不是也定义了各个不同场景的继承于抽象基类的继承类的反序列
public void CreateNewScene(int type) { // unity 里不同场景的编号不同， 这里以 int 值不同来区分不同的游戏场景
    ClearLastSceneGameObject();
    currentSelectGameObjectInstanceID = 100000001;
    SceneTypeData typeData = TypeDataManager.GetSceneTypeData(type);
    if (typeData.type == (int)ESceneType.Edit) {
        CurrentScene = new EditScene(type);
        CurrentScene.LoadSceneGameObject();
    } else if (typeData.type == (int)ESceneType.Show) {
        CurrentScene = new ShowScene(type);
        CurrentScene.LoadSceneGameObject();
    } else if (typeData.type == (int)ESceneType.Camera) {
        CurrentScene = new CameraScene(type);
        CurrentScene.LoadSceneGameObject();
    }
}

// 加载一个场景
public void LoadScene(SceneData data) {
    ClearLastSceneGameObject();
    currentSelectGameObjectInstanceID = data.GetMaxFurnitureInstanceID();
    SceneTypeData typeData = TypeDataManager.GetSceneTypeData(data.type);
    if (typeData.type == (int)ESceneType.Edit) {
        CurrentScene = new EditScene(data);
        CurrentScene.LoadSceneGameObject();
    } else if (typeData.type == (int)ESceneType.Show) {
        CurrentScene = new ShowScene(data);
        CurrentScene.LoadSceneGameObject();
    } else if (typeData.type == (int)ESceneType.Camera) {
        CurrentScene = new CameraScene(data);
        CurrentScene.LoadSceneGameObject();
    }
}

void ClearLastSceneGameObject() {
    if (CurrentScene != null && CurrentScene.GameObject != null)
        Object.DestroyImmediate(CurrentScene.GameObject);
}

public void CleanCurrentScene() {
    if (CurrentScene != null && CurrentScene.GameObject != null) {
        Object.DestroyImmediate(CurrentScene.GameObject);
        CurrentScene.Dispose();
        CurrentScene = null;
        Resources.UnloadUnusedAssets();
        System.GC.Collect();
    }
}

// 加载某个特殊的场景：那么就是说对于某类过于特殊的场景，可以将其单独打包成一个资源包上传服务器和从服务器下载下来加载
// 这里这个特殊的场景，好像不涉及任何其它数据（除了一个应用里的 SceneData）？所以过程极为简单，可以跳过很多步
// 再想一下：这个特殊的场景到底特殊在哪里，可以独立有条路路的加载方法？
public void LoadShowScene(string bundleName, string assetName) {
    string json = ResourceConstant.Loader.LoadTextAsset(bundleName, assetName, EAssetBundleUnloadLevel.LoadOver).text;
    //Debug.Log("json: " + json);
    SceneData sceneData = SceneData.JsonToObject(json);
    LoadScene(sceneData);
}
}

```

## 10 Data: 数据驱动

- **这里的问题：**同样是为了打包和拆包场景，为什么一个场景数据要定义成两种不同的场景类，相当于普通数据类型的装箱与拆箱操作么，为了自适应两个不同的程序集？序列化与反序列化？要好好想一想

- 前面有对 ViewModel 的适配包装，这里更多的是 frameworks 层如同 SquarePanda 里有专用的公司开发的 SDK 来对这一家公司里的 10 款游戏进行通用模块包装一样，这个游戏热更新框架可以理解为是对同一家或是几家相同架构设计的多款游戏的架构封装，那么各个游戏独特的数据类型 model 仍然该是封装在各自游戏应用的内部；framework 热更新框架只提取各个游戏通用的逻辑进行封装。

也提到说数据类型是

- 热更新所有的一切（资源包和程序包）都打包成数据上传热更新服务器，所以是数据驱动，一切都是数据!!
- 在把不同的所有需要热更新的东西全部打包上传服务器的过程中，背后本质是不同类型打包基类元件（资源包，场景等）的序列化（上传服务器）与反序列化（下载资源包后的加载过程?）
- 那么如何把不同的热更新类型打包封装成不同的数据呢（不同数据类型的自定义）

## 10.1 Data: 必要的序列化过程中自己封装成的自定义类型仍然可以或是需要定义在这里

- 我自己的游戏里写过俄罗斯广场砖的序列化与反序列化，可是我还不曾真正去读自己几年前写过的源码，忘得差不多了，该是时候把它们捡起来再深入发展一下了（爱表哥，爱生活!!!）
- 可以养成一个编程习惯就是说：凡是带 Data 作为后缀的，都当作定义为序列化数据的方法逻辑？

### 10.1.1 SceneData: 场景实例数据

```
// 场景实例数据
public class SceneData { // 再去多想一想，为什么要用 SceneData 与 SceneTypeData 相区分？
    // 实例 ID
    public int instanceID;
    // 场景类型
    public int type;

    // 这是同一家公司或是相同架构公司多个不同游戏的 framework 游戏框架通用管理
    // 接下来：需要对各自游戏应用各不同场景下的 Model 数据进行封装，封装到自定义的场景热更自定义类型里去
    // 可是用集合类对同一场景下的同一数据类型进行封装；
    // 同一场景下不同数据类型间，可以生成多个不同字典等集合数据结构进行封装
    // 单个数据
    public SingleData singleData;
    // 某数据类型的集合
    public Dictionary<string, TypeoneData> typeoneDatas;
    // 另一数据类型的集合
    public Dictionary<int, TypetwoData> typetwoDatas;

    // 反序列化
    public static SceneData JsonToObject(string json) {
        SceneData data = new SceneData();
        JsonObject jsonObject = JsonSerializer.Deserialize(json) as JsonObject;
        if (jsonObject != null) {
            if (jsonObject.ContainsKey("instanceID")) {
                data.instanceID = jsonObject["instanceID"];
            }
            data.type = jsonObject["type"];
            if (jsonObject.ContainsKey("singleData")) {
                JsonValue singleJsonValue = jsonObject["singleData"];
                data.singleData = SingleData.JsonToObject(singleJsonValue.ToString());
            }
            data.typeoneDatas = new Dictionary<string, TypeoneData>();
            JsonValue jsonValue = jsonObject["typeoneDatas"];
            JsonArray jsonArray = JsonSerializer.Deserialize(jsonValue.ToString()) as JsonArray;
            foreach (var value in jsonArray) {
                TypeoneData typeoneData = TypeoneData.JsonToObject(value.ToString());
                data.typeoneDatas.Add(typeoneData.gameObjectName, typeoneData);
            }
            data.typetwoDatas = new Dictionary<int, TypetwoData>();
            JsonValue jsonValue2 = jsonObject["typetwoDatas"];
        }
    }
}
```

```

        JSONArray jsonArray2 = JsonSerializer.Deserialize(jsonValue2.ToString()) as JSONArray;
        foreach (var value in jsonArray2) {
            TypetwoData typetwoData = TypetwoData.JsonToObject(value.ToString());
            data.typetwoDatas.Add(typetwoData.instanceID, typetwoData);
        }
    }
    return data;
}
public override string ToString() {
    return ObjectToJson().ToString();
}
// 序列化
public JsonObject ObjectToJson() {
    JsonObject jsonObject = new JsonObject();
    jsonObject.Add("instanceID", instanceID);
    jsonObject.Add("type", type);
    JsonObject singleJsonObject = singleData.ObjectToJson();
    jsonObject.Add("singleData", singleJsonObject);
    JSONArray jsonArray = new JSONArray();
    foreach (var data in typeoneDatas.Values) {
        JsonObject dataJsonObject = data.ObjectToJson();
        jsonArray.Add(dataJsonObject);
    }
    jsonObject.Add("typeoneDatas", jsonArray.ToString());
    JSONArray jsonArray2 = new JSONArray();
    foreach (var data in typetwoDatas.Values) {
        JsonObject dataJsonObject = data.ObjectToJson();
        jsonArray2.Add(dataJsonObject);
    }
    jsonObject.Add("typetwoDatas", jsonArray2.ToString());
    return jsonObject;
}
public int GetMaxTypetwoInstanceID() {
    int maxID = 100000001;
    foreach (var key in typetwoDatas.Keys) {
        if (key > maxID) {
            maxID = key;
        }
    }
    return maxID;
}
}
}

```

## 10.2 TypeData

### 10.2.1 SceneTypeData: 场景类型数据

```

// 这里可以自定义几个不同的场景类型，方便程序区分
public enum ESceneType {
    None = 0,
    Edit = 1,
    Show = 2,
    Camera = 3
}
// 场景类型数据
public class SceneTypeData {
    public long id;
    public string gameObjectName;
    public string name;
    public string description;

    public int type;
    public string bundleName;
    public string assetName;
    public string iconBundleName;
    public string iconAssetName;

    // 把序列化数据重新反序列化成 unity 场景数据
    public static SceneTypeData JsonToObject(string json) {
        SceneTypeData typeData = new SceneTypeData();
        JsonObject jsonObject = JsonSerializer.Deserialize(json) as JsonObject;
        if (jsonObject != null) {
            typeData.id = jsonObject["id"];
            typeData.gameObjectName = jsonObject["gameObjectName"].ToString();
            typeData.name = jsonObject["name"].ToString();
            typeData.description = jsonObject["description"].ToString();
            typeData.type = jsonObject["type"];
        }
    }
}

```

```

        typeData.bundleName = jsonObject["bundleName"].ToString();
        typeData.assetName = jsonObject["assetName"].ToString();
        typeData.iconBundleName = jsonObject["iconBundleName"].ToString();
        typeData.iconAssetName = jsonObject["iconAssetName"].ToString();
    }
    return typeData;
}
public override string ToString() {
    return "id: " + id + " gameObjectName: " + gameObjectName + " name: " + name + " description: " + description
        + " type: " + type + " bundleName: " + bundleName + " assetName: " + assetName
        + " iconBundleName: " + iconBundleName + " iconAssetName: " + iconAssetName;
}
}
}

```

## 10.3 static class TypeDataManager: 文件比较大, 仅以场景数据一种自定义数据类型来作分析

```

// TypeData 管理器: 静态管理类
public static class TypeDataManager { // 文件比较大, 仅以场景数据一种类型来作分析

#region TypeDatas
    // 对于每种自定义自封装的类型, 启用一个字典来进行管理; 同自定义类型的数据, 用一个长量型的 long 作为 key 来进行区分实例
    static Dictionary<long, SceneTypeData> sceneTypeDatas;

    public static Dictionary<long, SceneTypeData> GetSceneTypeDatas() {
        return sceneTypeDatas;
    }
    public static SceneTypeData GetSceneTypeData(long id) {
        if (sceneTypeDatas.ContainsKey(id)) {
            return sceneTypeDatas[id];
        } else {
            return null;
        }
    }
}
#endregion
// 对不同自定义类型的数据初始化
public static void InitializeTypeDatas() {
    string sceneJson = ResourceHelper.LoadTextAsset("scene/config/scene", "scene", EAssetBundleUnloadLevel.LoadOver).text;
    if (!string.IsNullOrEmpty(sceneJson)) {
        InitializeSceneTypeData(sceneJson);
    }
}
static void InitializeSceneTypeData(string jsonStr) {
    if (jsonStr != null) {
        sceneTypeDatas = new Dictionary<long, SceneTypeData>();
        JSONArray jsonArray = JsonSerializer.Deserialize(jsonStr) as JSONArray;
        if (jsonArray != null) {
            foreach (JsonValue jsonValue in jsonArray) {
                SceneTypeData typeData = SceneTypeData.JsonToObj(jsonValue.ToString());
                if (!sceneTypeDatas.ContainsKey(typeData.id)) {
                    sceneTypeDatas.Add(typeData.id, typeData);
                } else
                    Debug.LogError("sceneTypeDatas contains key: " + typeData.id);
            }
        } else
            Debug.LogError("sceneTypeData jsonArray is null");
    }
}
}
}

```

## 11 View

## 12 HotFixMain 静态类: 热更新程序的入口

```

// 热更工程入口
public static class HotFixMain {
    public static void Start() {
        Debug.Log("InitializeTypeDatas");
        TypeDataManager.InitializeTypeDatas();
        ViewManager.InitializeItemDatas();
        Debug.Log("HotFixMain.Start()");
        ViewManager.InitializeStartUI();
    }
}

```

```

    }
}

```

## 13 ILRuntime 类库里源码的基本理解，最重要的涉及到的相关的类与方法摘要

### 13.1 CrossBindingAdaptor : IType 跨域 (程序集) 绑定适配器 + Cross-BindingAdaptorType interface 公用接口类 (为什么要这个公用接口类?)

```

public interface CrossBindingAdaptorType { // 公用接口类
    ILTypeInstance ILInstance { get; }
}

// This interface is used for inheritance and implementation of CLR Types or interfaces
public abstract class CrossBindingAdaptor : IType {
    IType type;

    // 下面是定义的几个公用的抽象方法，供子类实现
    // This returns the CLR type to be inherited or CLR interface to be implemented
    public abstract Type BaseCLRType { get; }
    // If this Adaptor is capable to impleement mutuple interfaces, use this Property, AND BaseCLRType should return null
    public virtual Type[] BaseCLRTypes {
        get {
            return null;
        }
    }
    public abstract Type AdaptorType { get; }
    public abstract object CreateCLRInstance(Enviorment.AppDomain appdomain, ILTypeInstance instance);

    internal IType RuntimeType { get { return type; } set { type = value; } }

    // 反射机制的所有可能涉及的相关的方法定义; getters/setters
    #region IType Members
    public IMethod GetMethod(string name, int paramCount, bool declaredOnly = false) {
        return type.GetMethod(name, paramCount, declaredOnly);
    }
    public IMethod GetMethod(string name, List<IType> param, IType[] genericArguments, IType returnType = null, bool declaredOnly = false) {
        return type.GetMethod(name, param, genericArguments, returnType, declaredOnly);
    }
    public List<IMethod> GetMethods() {
        return type.GetMethods();
    }
    public int GetFieldIndex(object token) {
        return type.GetFieldIndex(token);
    }
    public IMethod GetConstructor(List<IType> param) {
        return type.GetConstructor(param);
    }
    public bool CanAssignTo(IType type) {
        bool res = false;
        if (BaseType != null)
            res = BaseType.CanAssignTo(type);
        var interfaces = Implements;
        if (!res && interfaces != null) {
            for (int i = 0; i < interfaces.Length; i++) {
                var im = interfaces[i];
                res = im.CanAssignTo(type);
                if (res)
                    return true;
            }
        }
        return res;
    }
    public IType MakeGenericInstance(KeyValuePair<string, IType>[] genericArguments) {
        return type.MakeGenericInstance(genericArguments);
    }
    public IType MakeByRefType() {
        return type.MakeByRefType();
    }
    public IType MakeArrayType(int rank) {
        return type.MakeArrayType(rank);
    }
}

```

```

public IType FindGenericArgument(string key) {
    return type.FindGenericArgument(key);
}
public IType ResolveGenericType(IType contextType) {
    return type.ResolveGenericType(contextType);
}
public IMethod GetVirtualMethod(IMethod method) {
    return type.GetVirtualMethod(method);
}
public void GetValueTypeSize(out int fieldCout, out int managedCount) {
    type.GetValueTypeSize(out fieldCout, out managedCount);
}
}
// Getter / Setter s
public bool IsGenericInstance {
    get {
        return type.IsGenericInstance;
    }
}
public KeyValuePair<string, IType>[] GenericArguments {
    get {
        return type.GenericArguments;
    }
}
public Type TypeForCLR {
    get {
        return type.TypeForCLR;
    }
}
public IType ByRefType {
    get {
        return type.ByRefType;
    }
}
public IType ArrayType {
    get {
        return type.ArrayType;
    }
}
public string FullName {
    get {
        return type.FullName;
    }
}
public string Name {
    get {
        return type.Name;
    }
}
public bool IsValueType {
    get {
        return type.IsValueType;
    }
}
public bool IsPrimitive {
    get {
        return type.IsPrimitive;
    }
}
public bool IsEnum {
    get {
        return type.IsEnum;
    }
}
public bool IsDelegate {
    get {
        return type.IsDelegate;
    }
}
public AppDomain AppDomain {
    get {
        return type.AppDomain;
    }
}
public Type ReflectionType {
    get {
        return type.ReflectionType;
    }
}
public IType BaseType {

```



```

        get {
            return type.BaseType;
        }
    }
    public IType[] Implements {
        get {
            return type.Implements;
        }
    }
    public bool HasGenericParameter {
        get {
            return type.HasGenericParameter;
        }
    }
    public bool IsGenericParameter {
        get {
            return type.IsGenericParameter;
        }
    }
    }
    public bool IsArray {
        get { return false; }
    }
    }
    public bool IsByRef {
        get {
            return type.IsByRef;
        }
    }
    }
    public bool IsInterface {
        get { return type.IsInterface; }
    }
    }
    public IType ElementType {
        get {
            return type.ElementType;
        }
    }
    }
    public int ArrayRank {
        get { return type.ArrayRank; }
    }
    }
    public int TotalFieldCount {
        get {
            return type.TotalFieldCount;
        }
    }
    }
    public StackObject DefaultObject {
        get {
            return default(StackObject);
        }
    }
    }
    public int TypeIndex {
        get {
            return -1;
        }
    }
    }
    }
#endregion
}

```

## 13.2

## 13.3

## 13.4

## 13.5